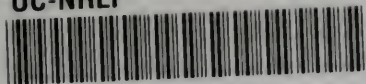


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NEW FINDINGS
IN OPHTHALMOLOGY
AND OTOTOLOGY

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MONROE J. HIRSCH, O.D., Ph.D.

NEW FINDINGS IN OPHTHALMOLOGY AND OTOTOLOGY

A MONOGRAPH.

WITH A DESCRIPTION OF TWO NEW INSTRUMENTS.

ILLUSTRATED.

SECOND EDITION.

By

E. H. HAZEN, M. D.

Lecturer on Ophthalmology and Otology Medical Department State University from 1870 to 1874. Emeritus Professor of Ophthalmology and Otology, College of Physicians and Surgeons, Medical Department of Drake University, Des Moines, Iowa. Member of the American Medical Association, Iowa State Medical Society, Etc.

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By

E. H. HAZEN, M. D.,

Des Moines.

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1911

OPTO

PREFACE.

He who essays to write a book in these times, should have a reason.

The incentives to authorship may be various—a desire to exercise a talent in expressing thoughts already promulgated by others; a desire for recognition in his own field of work; or a desire to make known the result of his labor in original investigation.

These are all legitimate motives, and the merits of his labor are always tested by the life of the book.

It is not my purpose to write a Text book, but a Monograph of the subject of the treatment of the Muscles of the Eye.

It is particularly gratifying, to be enabled, as I think, to contribute to the profession, some improvement in the science of Ophthalmology, in which I have spent the most of a long life.

I take the liberty of dissertating, in the introduction, on some of the late movements, in the handling of a class of cases, to which I contribute my method of treatment.

I have presented the history of this subject and the views of writers down to the present time, in excerpts from the authors, instead of appropriating their thoughts, and expressing them in my own words. I hope I have done no violence to these writings.

I believe that the means, I have devised for the testing of the muscles, not only add to the good management of those cases already recognized as having muscular troubles, but they include relief for a large percentage, which are now supposed to be outside the work of the Ophthalmologist.

INTRODUCTION.

A great division in the world's work is the combatting of disease. While the forces of nature are constantly propelling toward the higher and better samples of improvement, there is an antagonizing force which deteriorates this impulse. The first we call good and the second evil.

The mind of man attempts to grapple with the problem and abets, aids, directs and cultivates the one and prunes, hunts, cuts off and destroys the other. It is one of the wonderful products of nature that the mind of man, which itself has come up out of nature, should tower over nature and presume to direct its growth.

Nevertheless, when we compare rude nature and the work, which man is enabled to show as his, we are puzzled to decide which is the most wonderful.

We do not detract from the Creator in admiring, with awe, the direction which man has given to the many things on which he has put his finger, for he is but a servant of nature and must work by her laws and in contemplating the direction he has given to nature, and to that which he has wrought, he but glorifies the maker of himself, and the echo of achievement reverberates from generation to generation, and man becomes more civilized, lives in luxury and sings more praises to his God.

With the enumeration of all the benefits of civilization, there are elements of evil. The higher organization of man and that which enables him to have dominion over

nature consists of the development of his nervous system. With culture comes disease. Many are the examples in nature, where impulses have proceeded that seemed to be good, but have gone up and on until that very element has wrought its own destruction.

This development of the brain and nervous system, which enables man to do the work that shows itself on every hand, has, in the majority of mankind, refined, cultured and made more powerful and strenuous each succeeding generation, until in our own, we may estimate its capabilities as greater than any that have gone before, and we may anticipate that in the generations to come, there will be greater masters than in the present.

But these advances are made at a great cost; the strenuousness, the ambitions, the requirements of the habits of industry to attain the coveted goal draw upon the vitality of the nervous system, and the nature of man's physical and anatomical system is not prepared for the demands, which he makes upon it. When carried too far, pain comes as a warning, and when not heeded a break-down is the consequence and death of the unfit is the result.

No better example can be given of the exceedingly great demand upon the civilization of the day than that made upon the organ of vision. Not only is this organ continuously and excessively exercised in acquiring an education for the start in life, but it is upon this organ that we depend mainly for existence in the struggle of life, and upon it for the success of the greater ambitions which comes to the few.

The manual labor of the generality of mankind is becoming more and more narrowed down to the need of a limited action of the muscles of the eye, and but a few of the other muscles of the body; the necessities of many, indeed most of the occupations, require but little variety of motion, and this limited motion is more ex-

haustive on the nervous system than the occupations of our forefathers, which usually called upon the action of the whole muscular system in the performance of their duties.

The consequence is that we have a generation of abnormal hyperaesthetic nerve development, that is on the road to asylums and has for its end insanity.

Poor humanity resorts to alcohol, narcotics, opiates and sedatives to dull the disturbance. The requirements of an exhausted nervous system demand an abnormal excitement and stimulant; the already tired organ of vision seeks amusements other than those requiring further exercise of sight, and the social enticements lure them, and their environment is not always the best, and so bad habits are acquired, and waste of time and a lower or indifferent life is the consequence.

The type of American physique is a nervous organization and the attention of the American physician is particularly directed to this class of disorders.

From experience in these affections, and contact with others whom I have been teaching, it is my conviction that this disease is the most prevalent one in America. American people read more than any others. Her people develop faster because of those occupations, requiring near sight. Their ancestors used their eyes but little in convergence, and therefore had not cultivated a physiological condition toward the necessities of the new civilization, and had not transmitted them by heredity. These people, thus wanting in the advantages of heredity, have to cope with a disadvantage, in strange occupations, and are apt to break down in the race for life in the new environment.

The frequent appeal to the eye specialist, of those with nervous systems, for relief, and the growing importance of this work, which the oculist has gradually learned, in relation to the nervous diseases, and also, as

the author believes that he has a further contribution in this line, he takes the liberty of dissertating broadly upon the situation as he sees it, hoping that his thoughts may be considered, and weighed and turned out onto the tide, that flows in and out and purifies and improves the humanitarian's labors.

Notwithstanding that the pathology of nervous troubles has made some progress in the profession as to differentiation, when presented, by sufferers, to their friends, the troubles are, as a whole, about alike in character.

It makes a great difference upon which road they seek advice regarding them. If the patient has been to the Oculist, he emerges with a saddle and bridle on his face. If he is switched off to the Nervous Disease man, he is relegated to a Sanatorium and put to "rest." If to the Hydropath, he is massaged, soaked and washed inside and out. If to the Faith cure, he is persuaded, cajoled and hypnotized. Neither Specialist seems to have knowledge of any better method of relief. Some of them attempt to cure the symptoms by improving the general health, and others will take medicine and a vacation to build up the constitution, with the expectation that the symptoms (which the physicians say are caused by constitutional diseases) will depart. Others claim that the theories of disease are a delusion and a snare.

Each specialist is trained to believe that he is able to cure by his particular method. There is not that linking together of methods, that one would expect from these men, who have generally been educated in the same colleges, and belong to the same Medical societies—nevertheless, the Specialists represent a different Tribe and think on the lines of the particular specialty of their choice.

There is need of a combination of the knowledge attained in the world's work—unprejudiced, disinterested and philanthropic in its spirit to apportion its

application. The desirability of this has been seen of late, and some of the religious organizations have attempted to supply the necessity by a fusing of religion and medicine.

The movement takes up a different method of benefiting mankind from that heretofore practiced. It is a combination of the institutions that have been the closest to the social nature of man—the religions and medicine. The church, ostensibly, has been instituted to direct man in attaining to the best in this life and beyond the grave, and, to a certain extent, it has promoted a moral life, but of late years there has been more attention paid to matters of this life. The church is a social institution, and more than any other, looks after the welfare of its members. This mission is becoming more and more the work of the church. There is no other institution that affords such opportunities to guard and teach the social and moral phases of life. All communities need a corps of intelligent men and women, who will interest themselves in each others' temporal welfare and attend to the social up lift; associated with them should be the disinterested scientific man, who understands disease and sanitation. His education should be broad—a graduate in medicine—one who understands, not only the diagnosis of disease, but sanitation in all its branches—architecture—plumbing—landscape gardening—bacteriology and chemistry—physical culture etc., but *he should not be a practitioner of medicine*. This limit would place him at once before the people, as an unbiased adviser and as one, who would devote his energy to the combatting of the causes of disease. The Science of Sanitation would grow in the hands of such a promoter, for he would be an independent advisor in all branches.

The Minister, through his profession, enters into that field of labor, which gets closer to the social aspect of

civilization and comes in contact with the sympathetic and brotherly nature of man, more than any other. His education touches upon the finer and more esthetic nature and reaches man through impulses, that we classify as belonging to the heart. His training of mind and habits of thought fit him better than any other class of men to get to and direct social and domestic matters. His purposes and aspirations adapt him to win the confidence of his fellow men who toil and have not had or have not laid hold of opportunities to become educated or enlightened in the progress of the age.

These people need the helping hand of those, better educated, to enable them to adjust themselves to modern methods and thoughts, and to advise them where aid can be obtained. With the council of the man, scientifically educated, many of the difficulties and troubles, on the road to success, may be made smooth and comfortable.

Behind these two persons, who would come directly in contact with the public, might be a board composed of business and professional men, who would constitute a financial council and referee. This is not too formidable, in the light of what is already organized in some of the churches of the east.

The weakness of these organizations that have attempted this combination, is in the association of the church with specialists of Nervous diseases, and *they* practitioners of medicine.

The Advisory board would have a distinctive work that would be accepted as most free from sinister motive, and would be more free from suspicion of graft than any other source from which to get advice. It ought to be mostly supported by the benevolent contributions, but not wholly, for the best charities of the day require of the person benefitted, some remuneration for time and service.

The majority of the people need the council of the educated, the experienced, the broad-minded, honest, true philanthropic friend. Many men and women, who pass for intelligent people, place their expectations of success on a wrong basis for results. They do not understand the laws of nature nor of society, and when in trouble, or when being carried away by emotion or passion, make mistakes that wreck their lives.

The Missionary spirit of the church and the accumulation of moral ethics, which it has stored away, and the reputation it has for true philanthropy ought to be directed more to the mundane relations of men and the direction of their purposes—the building up of the physical man—enlightening his mental and moral nature—clarifying society and directing the rearing of the coming generation.

From our experience in the past, shall we not look for a scientific solution of all the problems with which we seek to benefit mankind, mentally, morally, and physically, and shall we not put our faith in this method to bring about our happiness and thrift?

The Alchemist, in former generations, with a sordid motive it is true, dissipated a mystery and found nature's well defined laws in the atoms, which are so small that they have not yet been seen, and the result is, that the beautiful and practical science of chemistry has been established.

Pathology groped its way in superstition for ages, until the Microscopist increased the convexity of his object lens and immersed it; when the science of Bacteriology was instituted and sanitation was born again; salvation for millions was guaranteed; fevers are now harnessed, and climates are habilitated, and man's plans are made possible when before they failed.

Accoustics, as a science, was a mystery. Edison, following the wave theory and taking the pattern of the

ear, put a needle into an artificial drum and we record the sounds in wax. The telephone is half brother to this and again mystery is materialized.

We have now, on our hands, the theory of mind over matter. Whispers of solutions load the printing presses. The subject is so mysterious that superstition envelopes it as it did other questions of yore, but if it is ever solved, science will do it. But, some will ask. what has *this* to do with eye strain?

We have, in this subject, phenomena that are widespread, and the syndromes of the particular groups are so different in manifestation, and some so remote from the organ of vision, affecting the system so differently and implicating the mental, moral and physical nature of man, so that all the "pathys and ologies" take it up, and build into their doctrines an explanation of and a remedy for them. Some of the theories open out a way toward a proper basis for their solution, and others are but stumbling blocks.

The nervous organization of man, which has so far out-reached that of other species, becomes more and more intricate, and most of the troubles with which we have to deal, being symptomatic, functional and phenomenal and so far from our instruments of precision, that opinions regarding them must necessarily be various.

Many a problem has been delayed in solution, because of a wrong direction being taken for its mastery, and at last it was conquered by a simple method.

EYE STRAIN AND ASTHENOPIA.

DEFINITIONS AND DESCRIPTIONS.

One of the most interesting histories in medicine is that of the growth of, and advancement made in the understanding of the functional troubles of the organ of vision. There is no other organ of the body (unless it be the brain) that is so intricate, subtle and so slow in being understood.

We have had in science, some of the brightest geniuses, who have given us the fruits of their labors; among them, Young, Helmholtz, Donders, Von Graefe and Noyes, who have worked in this particular field and others who are still alive and have not finished their work. To the fruits of the labor of these men, the world is indebted for the means by which it is enabled to do the work which civilization and new methods of labor have entailed. They have furnished the treatment that relieves a greater number in the realms of suffering humanity, than any of the other specialists in medicine, and *yet* there is room for progress. The pendulum will swing from one side to the other in the emphasis of theories and practices, but it will be in the hands of men still alive, and if they have the metal of those whom we mention as having died, ere another generation will have passed, they too will hand in valuable contributions and make advancement in this beautiful science.

Denouncements and indifferent attitudes, will always be the reception given by many, to departures from

staid methods and authority; however, when the new principles come to men who have courage, and who avow them, there are sometimes those, who take hold of the new ideas with great avidity and enthusiasm, but, very often many of them are so imperfectly demonstrated, that other minds do not understand them as the author did and hence, those attempting to practice them do not get the same results. This truth cannot be better illustrated than in the intricate physiology and pathology of the eye, and a single step forward in this science deserves attention.

We will, as far as possible, examine the authors of the day, regarding the main points of the functions of the organ of vision, and endeavor to get at the status of the subject of disorders connected therewith, and as held by the profession at the present time. We will examine the position taken by the authors of our day, in the order of the date of their writings. In the examination of the subject by the inquiries adopted, we can best set forth the development of the science and show the steps taken therein, and thus be enabled the better to compare them with what is here offered as a new contribution.

INQUIRIES.

- 1st. Terms. Eye strain, Asthenopia, both accommodative and muscular, as words to encompass disorders of the function of sight.
- 2nd. The doctrine of Insufficiency of the Muscles.
- 3d. The Relation of Ametropia to Muscular Anomalies.
- 4th. The Theories of Balance and Equilibrium and the Relation of Imbalance to Eye disorders.
- 5th. Dynamics of the eye muscles and gymnastics in the treatment of them.
- 6th. As to Epilepsy, Chorea, Hysteria, Migraine etc., to Asthenopia.
- 7th. The Relation of Eye strain or Asthenopia to Constitutional symptoms.

PART I.

EXCERPTS FROM SPECIALISTS
IN OPHTHALMOLOGY.

The thoroughness with which Prof. Donders of Utrecht systematized the subject of Refraction, would be difficult to parallel in the history of the science of Medicine.

Its importance, and the benefit accrued to the world, and that yet to come, cannot be estimated. He wrote out of chaos, mystery and ignorance, a beautiful science and habilitated it with art, order and precision. He put it forth on the road to exactness, and with becoming modesty, bid it improve.

1864.

F. C. DONDERS, M. D.

*Professor of Physiology and Ophthalmology in the University of
Utrecht.*

Translated by

WILLIAM DANIEL MOORE, M. D.

**ANOMALIES OF ACCOMMODATION
AND
REFRACTION OF THE EYE.**

ASTHENOPIA.—Prof. Donders' early history of asthenopia tells us, that it received a variety of names, which but covered up ignorance of the phenomena. "Dimness of vision"—"Affection of the retina from excessive employment"—Disposition to fatigue—"Slowly adjusting sight"—Impaired vision from overwork. "It is evident that in a condition such as this, there was great difficulty in sketching a typical picture, so long as the cause of the leading feature of the affliction, and therefore its nature was unknown". . . .

"The well defined lineaments of the picture were obliterated by unessential phenomena, and mixed up with those of amblyopia . . . and were generally sought in the retina or in the choriadea."

EARLY IDEA.—As to the affection being caused by accommodation in the time of Mackenzie, it was met by the theory of Bohm who ascribed it to the external muscles of the eye, and was the first to recommend the use of convex glasses for the trouble of asthenopia, but he gave too weak ones.

Ruete adopted Bohm's theory and concluded that the "proximate cause, as proved by Bohm, was a weakness of the motor nerves of the eye." From the fact noticed, that complaints were made by persons, who were almost constantly occupied, with close work, and who, on its suspension, showed immediate improvement—it was asked, should not the affliction be considered as a purely acquired condition, and the cause of it be sought in excessive tension?" Although at first, asthenopia lay concealed in amblyopia, it gradually emerged from its obscurity, and without the participation of the retina being as yet denied, its seat was sought more and more, in the organs of accommodation, until, at last the retina was almost completely excluded, and the condition was looked upon as a disease of the motor nerves and of the organ of motion of the eye."

At this time the source of the power of accommodation had not yet been discovered. There was as much reason to assign the principal part in that function to the external muscles of the eye. This led to the supposition that asthenopia was to be sought in a spasmodic contraction of some external muscle of the eye." "The cause of asthenopia was sought in the external muscles of the eye, and the results obtained on division of the latter were supposed to furnish a fresh proof of the correctness of the views of those who referred it to them."

AFTER DISCOVERY OF ACCOMMODATION.—After the discovery of the principal of accommodation, nothing more was said of the principal of abnormal pressure of the muscles of the eye, nor of dividing the latter as a remedy for asthenopia."

Von Graefe, "assigning to asthenopia only a symptomatic signification, demonstrates the existence of asthenopia muscularis, proceeding from insufficiency of the muscoli recti interni."

DISCOVERY OF HYPERMETROPIA.—"Our knowledge had reached this point, when I discovered the cause of asthenopia in the hypermetropic structure of the eye. The supposed anomaly of accom-

modation then became an anomaly of refraction. The connection of asthenopia with the circumstances under which fatigue is manifested was made most clear; the necessity of complete relief by spectacles was proven, while at the same time, the hope of a radical cure of asthenopia was extinguished forever."

The exaggerated attention to the external muscles, during the period of operation for strabismus, before his time, he thinks caused the pendulum of progress to swing too far that way.

"We must beware of mistaking *apparent* for *true* asthenopia." Then he describes a case of undoubted asthenopia or akinesis, in which he finds hyperaesthesia outside and in, and puts on dark glasses.

ASTHENOPIA.

Accommodation and Refraction.

SYMPTOMS.—"A peculiar morbid condition of the eyes has long attracted the attention of Ophthalmologists. The phenomena of which it is composed are highly characteristic. The eye has a perfectly normal appearance; its movements are undisturbed; the convergence of the visual lines presents no difficulty; the power of vision is usually acute; nevertheless, in reading, writing, and other close work—especially by artificial light, or in a gloomy place, the objects after a short time, become indistinct and confused, and a feeling of fatigue and tension comes on—especially above the eyes, necessitating a suspension of work. The person so affected often, involuntarily, closes his eyes, and rubs his hand over the forehead and eyelids. After some moments' rest, he once more sees distinctly, but the same phenomena are again developed more rapidly than before." (Sunday interval-rest.)

"The tension above the eyes gives place to actual pain, sometimes even slight redness and a flow of tears ensue. Everything is diffused before the eyes, and the patient no longer sees at first well, even at a distance. After too long continued tension, he is obliged to refrain for a long time from any near work. It is remarkable that pain in the eyes themselves, even after continued exertion, is of rare occurrence." "At first this condition was considered as a sort of amblyopia. It was called '*habitudo visus*'."

CONGENITAL PREDISPOSITION EXPLAINED.—"By degrees the cause was sought, more and more in the organ of accommodation—at first in the action of the external muscles, subsequently, in that of the internal muscular elements, and in the same measure, the importance of the retina was thrown into the shade. Excessive tension

of the accommodation was looked upon as a satisfactory cause of the troublesome symptoms, which, it was hoped, might be overcome by rest." "Since the same cause does not produce, in every one, the same deviation, writers are accustomed to take refuge in a *peculiar predisposition*. Thus the difficulty is set aside, but, if the foundation of this peculiar predisposition be dark and obscure, pathogeny has gained but little from the adoption of this course. I therefore felt called upon to propose to myself the question, on what the so-called predisposition to *asthenopia* (so the condition was now more generally called) might depend upon, and I soon became convinced that a congenital deviation, namely, a moderate degree of hypermetropia was at the bottom of it. The hypermetropia is here, however, more than predisposition. The asthenopia—I mean the tendency to fatigue in looking at near objects, is already included therein. Every hypermetropia, which, with reference to the range of accommodation, has attained a certain degree, is, at the same time, asthenopia. If the symptoms, sometimes do not manifest themselves until twenty-five years of age, or even later, this is to be ascribed merely to the fact, that previously, the range of accommodation was sufficiently great, to easily overcome the existing degree of hypermetropia." "We should beware of confounding the exciting circumstances of the phenomena which consist in continued tension in looking at near objects; the cause, on the contrary, is the hypermetropic structure of the eye. In fact, asthenopia is not fatigue itself, but the want of power through which the fatigue occurs. The distinction, made here, is applicable to other conditions—for example, climbing a hill. "I have already asserted that hypermetropia is usually at the bottom of asthenopia. The truth of this assertion has been doubted. I now, however, go a step farther, and venture to maintain, that in the pure form of asthenopia, hypermetropia is scarcely ever wanting." "When inconvenience was felt on continued exertion, this appeared to some, sufficient to justify the inference that asthenopia existed. On this account, different forms of irritation, congestion in myopic eyes, hyperaesthesia of the eye, with increased pain or exertion, different affections of the retina and of the choroid, nay, even the beginning of trachoma, and foreign bodies in the sac of the conjunctiva, might all be united under one denomination, but I cannot concur in the adoption of such a punitive, semiotic method. It leads inevitably to confusion of ideas and conditions. "The condition for the occurrence of asthenopia may now be still more generally formalized; it is the presence of a rather considerable, but yet at the same time, insufficient range of accommodation. Now, in

general, this insufficiency is attributable to Hypermetropia, as has been fully explained, but it may proceed also from want of energy. This last occurs exceptionally—especially in general weakness, from loss of blood or otherwise, and in paresis. In both of these conditions there is this peculiarity, that a brief but rather powerful muscular exertion is possible, but that the energy employed is almost immediately lost. We observe this in all muscles, and it is true also of those of the eye.” “There are still other morbid states, whose symptoms have some resemblance to those of asthenopia. To those belong especially, insufficiency of the external recti muscles, which Von Graefe has studied with such excellent results—myopic eyes, where this insufficiency is more particularly apt to occur.”

“This form was distinguished by Von Graefe, under the name of *asthenopia muscularis*, from that here described which may be here called the accommodative asthenopia.”

MUSCLES.

FATIGUE.—“The phenomena of asthenopia proceeds from nothing else than from fatigue of the muscular system of accommodation. In what this fatigue consists, deserves to be more closely examined.” “In my investigations respecting the elasticity of muscles, I have distinguished two forms of fatigue.” “One form proceeds from the actual energy produced by the muscle. The work consists in the moving of a load. The load may be the body itself or some part of the body, which is moved, or, in addition thereto, an object external to the body.” “Distinguished from this is the fatigue, which is the result of the simple extension of an elastic muscle in state of contraction. This takes place when a burden is held without being moved, as for example, when, with the arm bent at a right angle at the elbow joint, the hand is loaded with a weight; the arm and the weight remain in the same place and yet fatigue soon occurs.” “It has, in fact, been proved that, according as the muscle becomes fatigued, its extensibility increases, and this increasing extensibility requires augmenting contraction, in order, under the extending action of the same load to keep the muscle as short as it was.” “There was continually some actual energy in the oscillations of the electric currents, and most likely converted into heat.” “I therefore think the fatigue proceeding from the performance of labor, must be distinguished from that arising from simple extension.” “In explanation of the fatigue, which is the result of the performance of labor, we may take refuge in an accumu-

lation of products of metamorphosis of matter in the muscular tissue, which really goes hand in hand with it. The fatigue proceeding from extension, under the influence of a load not further moved, may, partly at least, have another source. Thus the extension might give rise to pressure on the nerve filaments in the muscle." "Probably, however, it depends partly also on an increase of the products of the metamorphosis of matter in the muscular tissue, produced, not so much, by the accelerated formation, as by retarded elimination." "Now, to which form of fatigue does that belong, which arises from persistent accommodation for accurate vision in the hypermetropic eye?"

MUSCULAR ASTHENOPIA.—He describes *Asthenopia Muscularis* under the head of *Myopia*. "Diverging Strabismus" is generally combined with *Myopia*." He says, "in cases of astigmatism, physical fatigue is soon created, with which, under some circumstances, as the result of the excessive tension of accommodation, phenomena of asthenopia are combined."

Under *Myopia*, he refers, to Von Graefe's operation for insufficiency of the interni. He had no knowledge of prisms as a means of exercise, but refers to them as used by Von Graefe, as a disagreeable means of correcting diplopia by wearing them.

INSUFFICIENCY OF INTERNI.—"If the one eye, so soon as it is covered, preceptibly deviates outward, and on removing the hand again turns inward, in order to resume its former direction, we may suspect the occurrence of asthenopic muscularis. It is often difficult enough to decide what is to be done in such cases, for the rules applicable to insufficiency of the internal muscles in non-myopes, by no means hold good in asthenopia muscularis in myopic individuals. In the former, the condition referred to is, in the first place, free from danger, and it is even allowable to try, by systematic practice with prismatic glasses to excite energy of the external muscle. In myopia on the contrary, cure of the insufficiency of the internal recti muscle is not to be thought of. Once begun, the insufficiency develops itself, more and more, in double proportion when, as is usual, the myopia is progressive. Often no other result is possible, than the exclusion of the one eye, with diverging strabismus. In the worst cases the mobility is even so limited, that it is insufficient both inwardly and outwardly."

There was a notable meeting of the American Ophthalmological Society which it would be a great omission to leave out of a history of the subject, which we are endeavoring to elucidate. This paper and its discussion, was the initiative of muscular discipline, as a remedy for eye strain, and awakened a new idea on the subject of asthenopia in this country.

The paper was given in a full meeting at which many prominent eye men were in attendance and took part in the discussion.

The description of the condition of these cases showed that those present had met with similar experiences, and the discussion was animated and interesting. (This is but a synopsis of the paper and its discussion.)

June, 1865.

MEETING OF THE AMERICAN OPHTHALMOLOGICAL
SOCIETY, NEW YORK CITY.

DR. EDWARD DELAFIELD, President, in the Chair.

DR. HENRY D. NOYES, Secretary.

“ASTHENOPIA NOT CONNECTED WITH HYPERMETROPIA.”

By

E. DYER, M. D.

ASTHENOPIA WITH NO HYPERMETROPIA.—Dr. Dyer said, “In these cases, there was no hypermetropia, latent or apparent.” “The majority of his cases were myopic; good accommodation; did not complain of words becoming indistinct, but had absolute pain, so disagreeable that they ceased to use their eyes; rest did

not relieve; pain or sensation lasted for several hours, sometimes, over night and next day; some intolerance of light; could go to theater or opera if excited, no feeling of discomfort at any time, but the next day or two would suffer the penalty; the pain produced by indiscretions of this kind was almost exactly like that brought on by using the eyes;" (near point) is mostly found in persons 30 years of age, and almost restricted to persons of the better class of society; have never seen it in strabismus convergens, but sometimes in strabismus divergens; have seen only one case complicated with astigmatism. The Ophthalmoscope generally, shows nothing abnormal; frequently, the optic nerve is not clear." He was led to the conclusion that there was some trouble with the accommodation that caused the pain. but in emmetropia and in myopia both complain of asthenopia. He did not detect insufficiency of convergence, but thought there might be a discrepancy between the power of the ciliary muscle and the angle of convergence.

DISCUSSION.

DR. DELAFIELD.—Dr. Delafield, said, "He had, in forty years, seen so much of asthenopia of this kind, that he must describe some that had come to his notice. One case, the wife of a classmate of his, had not read or written since 1812; another of the same kind, 80 years of age, with the same effect; the disease generally occurs in young people, but no age is exempt from it; the common direction is, "to rest your eyes." He never knew one to get well by resting the eyes. The difficulty occurs very largely in girls' boarding schools where hysteria is seen, and bad hygienic measures are found; symptoms are very much alike; the variety is not material; has not found a large proportion with myopia; after using eyes, "the eye sight blurs."

DR. DERBY divides the conditions of cases of asthenopia into two classes—1st. those where continued use of eyes is optically impossible. 2nd. Those where the same is physically impossible. The description of Donders suffices for the first, and the symptoms, indistinctness of vision from effort, with pains in head, flow of tears and disposition to close the eyes, the second. Under one or other of these classes, every case of asthenopia can be brought. The physical division is as little understood, as in 1858, when Donders first wrote, and when firmly fixed, is as little amenable to treatment; often absent in the invalid, and present along with the most vigorous health—a complete enigma as to its seat, its cause or cure; more common in this country than in Europe, and more common on the Atlantic seaboard than in the West.

The ocular class, generally congenital, is reducible to two causes, hypermetropia and insufficiency of the internal recti. Out of the 1800 cases in general practice, 369 were asthenopic; of these 241 belonged to the physical and 125 to the ocular; nearly all the latter were dependent on hypermetropia.

In true asthenopia, the eye is, to all appearances, both externally and internally, absolutely normal; no hypermetropia; interni of normal strength; general health may be satisfactory, but often is not. Sometimes, under the influence of alcoholic stimulus, or the excitement of important business, the eyes are used with apparent ease, and when excitement ceases, they relapse into their old condition. The affection may last weeks or a lifetime, and, in the majority of cases, resist any and all therapeutics.

DR. WILLIAMS OF CINCINNATI.—Dr. Williams of Cincinnati, during a number of years, has found a great many of this kind of cases, that, after repeated examinations, have excluded all idea of the usual cases of asthenopia, such as myopia, hypermetropia, astigmatism or paralysis of accommodation; that with sight perfect; range of accommodation normal and ophthalmoscopically perfectly natural; the patients were unable to use their eyes any length of time without feeling great inconvenience. These cases had often been told that they were threatened with amaurosis and must not use their eyes. This apprehension I try to remove, by telling them, they could not get blind if they were to try. From much reading and study, my own eyes became asthenopic, and I became apprehensive that I might lose my sight, and Von Graefe, on examination of them by the Ophthalmoscope, assured me that there was but a little nervous irritation, and I have done nothing for them, except to use my eyes a little more reasonably. One case, coming to me, had not read five lines at a time for twenty years. I fitted the Presbyopia and she has been using her eyes as much as she pleased, with very little inconvenience.

DR. WILLIAMS OF BOSTON.—Dr. Williams of Boston. "My attention was drawn to these cases, (before I had anything to do with them) which were called, 'morbid sensibility of the retina;' they were subjected to rather an active treatment, local depletion and low diet, and directed to absolutely refrain from the use of their eyes. These patients suffered from dread that they were to be blind, and they had readily taken advice to refrain absolutely from using their eyes, so as not to 'strain them,' and sometimes, they would shut themselves into a dark room. A charlatan of the early days, with a good deal of tact, took these hysterical patients, and

by putting them to bed for a day, with strong alkaloids on their eyes, and changing the diet to roast beef and stimulants, with frequent drives about the country, taking away all their old associations, caused his patients to do extremely well, and the quack was considered a prophet. He ascribed much more importance to the general treatment than to local applications, which were of an agonizing character, and were used to make an impression on the patient rather than on the disease, but it answered the purpose in making an impression on the disease psychologically."

"In Ophthalmological examination of such cases, I did not often find the slightest tendency to amaurosis, and I encouraged my patients to use their eyes all they possibly could. I prescribed tonics and placed them in cheerful surroundings, instead of having their minds constantly filled with morbid fear, and I sometimes gave them convex glasses, which I found to be good in some cases, not knowing, at that time, much about hypermetropia, as we now know it.

DR. SANDS.—Dr. Sands reported a case of the "Optical variety," coming under his observation. "A young man at 17 years of age, living in New England had been sent abroad to complete his education, and also to spend a couple of years in Europe. He was in perfect health; after spending two or three months about the Rhine and in Switzerland, he returned to Paris and began to experience pain on use of his eyes. He had never been a very hard student and he was very much surprised at the occurrence, and went to a well known oculist in Paris, who told him, 'that he was suffering from hyperaesthesia of the retina.' The physician created an immense amount of alarm in the mind of the boy, and placed him under treatment of a complicated character; remedies external and internal; told him to avoid use of his eyes, and under no circumstances to apply himself to work, in less than a year. His parents sent for him to come home, and he consulted me. I found a slight myopia, accommodation 1-4, vision good, no blur; the pain was in the ball; could discover no disease by ophthalmoscopic examination, excepting capillary hyperemia in the optic nerves; vision above normal; physical health good; mental depression on account of the advice given by the Paris oculist. He suffered no pain when looking at distant objects, but only when the ciliary muscle was brought into play during accommodation. Following Donders in 'inordinate contraction of the ciliary muscle,' I prescribed convex glasses of 20 inch focus, but when the optic lines were made to converge upon near objects, it was about as painful as it had previously been to exert it without glasses.

Donders suspended the accommodation by atropine, and used convex glasses in place of the accommodation, and thus cured the spasmodic contraction. These facts lead us to look for an explanation of asthenopic symptoms in the apparatus of accommodation in the ciliary muscle and the nerves that supply it, rather than in the errors of refraction or any disturbance relating to general health.

DR. NOYES.—Dr. Noyes led the discussion, which thus far related chiefly to one class of asthenopia. "I think it will not be amiss, cursorily, to run over some of these diseases, which, in the general classification of medical men, are included under the name of Asthenopia. Mackenzie, I find to be, "Incapability of sustaining the eye in adjustment for near objects." Lawrence, "An affection of the retina from excessive employment, commonly called, "weakness of sight"—Mackenzie grouping symptoms around adjustment, and Lawrence grouping the symptoms around a morbid condition of the retina—Stellwag Von Corion, "The inability to keep the dioptric system on the visual lines, for a long period, directed to near objects; and secondly, in close pathological relation to the condition hyperaesthesia of the retina and ciliary nerves."

"This definition of asthenopia is unquestionably the definition, which we would be most likely to adopt, but there is a tendency to exclude from the definition of asthenopia, all those cases of refractive errors and muscular disturbances, which are not properly disturbances of the ciliary muscle, but include cases in which neuralgic symptoms predominate. This is the meaning which the term is gradually assuming. Such was not formerly the understanding of asthenopia, and we all know perfectly well that, at least, two or three well recognized sub-divisions can be made—1st. Errors of refraction, principally hypermetropia and astigmatism.

2d. Insufficient power of the internal recti muscles; they, cannot perform their work of converging the visual lines, when the eyes are engaged upon near objects. 3d. Characterized by excessive irritability of the retina, accompanied by ciliary disturbance or neuralgia of the eye, extreme intolerance of light, with no lesion, no organic change, with vital powers, normal standard. Enough has been said on the subject of hypermetropia, astigmatism, and myopia. I desire to recall these facts. The insufficiency of the internal recti muscles has a nearer relation to the subject of asthenopia, in the aspect in which we are now disposed to view it, than to the simple errors of refraction, because this muscular part requires to be exerted in all use of the eyes upon near objects. The accom-

modation and muscular convergence are inseparably connected. The correction of this difficulty is accomplished in one of three ways—division of the external recti muscle; by use of prisms or what has recently been suggested, the employment of electricity to the internal recti muscle (Here Dr. Noyes introduced a readier method of detecting insufficiency).

In regard to cases to which the term hyperaesthesia of the retina may properly belong—*Case*—A physician, a surgeon in the Navy, who had been stationed on the African coast, and subjected to the intense light of the tropics; extremely sensitive to light; he not only could not use his eyes but was rarely free from neuralgia. He had subjected himself to all sorts of treatment; had almost poisoned himself with strychnine. After about five years, he came under my observation. There was no departure from normal structure; no deficiency of accommodation or any other function. I assured him there was no danger of becoming blind, and that he would probably be better. Out of door exercise, with blue glasses and avoidance of the use of his eyes, resulted in benefit, and after about six months on shore, away from the irritating influences to which he had been subjected, he recovered the use of his eyes and again went to sea.

Another case—That of a physician with the same misfortune—Ophthalmoscopic examination, with as little gas light as I could get along with, produced agonizing pain for 24 to 48 hours; attempts to read or fix eyes on distant objects, as well as near, provoked extreme pain. There was no error of refraction, impairment of vision, or muscular disturbance; general health fully up to the average. I could regard this case in no other light than one of extreme irritability, whose starting point was the retina, and which was reflected upon the ciliary muscles and nerves.

These several categories of Asthenopia, will hereafter, be known by their proper designation of errors of refraction, debility of the internal recti, hyperaesthesia retina. The term Asthenopia is, at the present time, when used to designate a distinct disease, and not merely a symptom, being narrowed down to cases of ciliary spasm or neuralgia."

TREATMENT.—Dr. Dyer seems to be the first one, who introduced a system of gymnastics for the muscles of the eye, which he added to the general course of tonics and hygiene. He "changed the relation of the accommodation to the angle of convergence of the axes by glasses," by giving them a light convex glass. He gave them explicit directions to never use their eyes without glasses,

and never use them except as directed. Taking the clear type of medium size, the patient must read at first, from 3 to 15 minutes (according to the case) morning, noon, and evening (before sunset) adding a minute to each sitting; if pain arose, which lasted to the time of the next reading, make the time a minute less, but always read at the stipulated time. A point will soon be found at which the patient can read without pain—then, to the time, he can add a minute a day, and when he gets to 30 or 40 minutes, three times a day, he may use his eyes at other work, but not until then. When he reaches an hour of reading, the glasses may be dispensed with.

The explanation, the rational and the new hope held out, together with the mental discipline and interest, gives to these cases, who have been told that they must rest, and that there is danger of their becoming blind, renewed energy. Out of forty of these cases, the results have been highly satisfactory.

The necessity of persevering and following directions is emphasized. If they become careless and read too much or irregularly, they will be sure to be thrown back and have the whole ground to go over again. The treatment of these cases extends over months, and they often relapse from indiscretion.

Dr. Delafield considers the principle of Dr. Dyer's method a correct one and has applied it for years—that is—in general diseases, he insists on exercise. He says, "The cure of the patient's general health is the foundation of everything. I am specific in direction as to this. Locally, I apply a sol of veratria or aconite to the nape of the neck, and from this application, urge them to read fifteen minutes. I sometimes use ammonia and alcohol, applied to the forehead, temples and neck. Each day one of these is used. I have used a solution of a grain of veratria to the ounce, dropped into the eye, in obstinate cases of asthenopia. It is painful and I get along without when I can." The exercise, instituted by Dr. Dyer, called for the forced use of the eyes not stopping because of pain.

DR. DERBY.—The original method of treating asthenopia, was neutralizing the manifest hypermetropia and keeping pace with the manifest, until all became manifest. Much stress was laid on the necessity of making the neutralizing glass part and parcel of the eye, and only laid aside when the eye ceased to see. It is now proved that the assumption that accommodation cannot be used on distant objects without injury, is fallacious. We may therefore, allow the patient, who sees distant objects fairly well, to use his glasses only for the near.

DR. WILLIAMS of Cincinnati, believed in exercising the eyes and had used Dr. Dyer's system, without exactly knowing why. He said, "I have tried it in two cases. I used moderately convex glasses and applied a solution of the sulphate of morphia—two grains to ounce—dropping three or four drops into the eyes, three or four times a day. Gave tonics constitutionally, and douched the eye with cold water twice a day."

DR. WILLIAMS of Boston—Constitutional medicine, tonics and moderate exercise. No use of eyes when ill. Found glasses were of benefit in hypermetropia. Encouraged patients to use eyes, increasing their use gradually.

DR. NOYES, considered the system of Dr. Dyer, in using a convex glass required a little greater effort of the internal recti, by bringing the near point nearer, while a systematic training developed their strength. He says, "I have seen benefit from wearing weak prisms when I did not feel certain that the interni were at fault. A combination of $+1. D. \subset 2^{\circ}$ prism has relieved a troublesome asthenopia. With these contrivances, there occurs a change in the relative accommodation—not as by use of convex glasses, yet the eyes accommodate, under conditions, unlike those to which they have become accustomed.

It was brought out in the discussion, by inquiry, that Dr. Dyer had no particular method, besides those commonly used, to determine whether his patients had insufficiency of the interni. He was satisfied to change the relation between accommodation and convergence, and endeavored to establish a more perfect relation between the two. He said, "I have doubted whether the benefit derived from prisms, was because of the relief to the internal recti, and not rather because of the modification in the condition of accommodation."

DR. ALTHOF had seen a great deal of the application of electricity to the eyes, but had never seen any benefit, whatever, derived from the use of it. As far as the treatment of these cases of asthenopia, by glasses was concerned, it was becoming more important and if the providing of glasses were facilitated, there would be less of asthenopia. High degrees of insufficiency do not always show diplopia with red glass.

The early history of the specialty of Ophthalmology in this country, received much of its impetus through the labors of Charles Bader, as shown in the following named book—although it was published in England.

1868.

THE NATURAL AND MORBID CHANGES
OF THE
HUMAN EYE AND THEIR TREATMENT.

By

CHARLES BADER,

Ophthalmic Assistant Surgeon to Guy's Hospital.

ASTHENOPIA.—Weak sight, impaired vision, slowly adjusting sight, affection of the retina from excessive employment. The two groups of muscles, which, from want of power, may give rise to asthenopia, are the ciliary muscle and the external muscles of the eye ball.

The term, Accommodative Asthenopia has been used by some to distinguish asthenopia, which is due to want of power of the ciliary muscle. Many symptoms accompanying asthenopia, do not essentially belong to it. In true asthenopia, when engaged in "near work," letters or finer details become "dim" or disappear. After rubbing or closing the lids, they can resume work for a short time; attacks of dimness vary in frequency; they appear sooner in ill health; they may continue for years without interfering with acuteness of vision. In hypermetropia, dimness is preceded by sensations of tension over eyebrows, amounting sometimes to pain. It has been stated, that the age at which asthenopia appears, is about equal to the denomination of the fraction (inch system) which expresses the degree of hypermetropia. Only the true asthenopia, as a rule, is cured by convex glasses.

APPARENT, NOT TRUE ASTHENOPIA.—Patients, at near and distant vision, complain of pain, aching, watering, pain in ciliary region and back of eyes. Pain may be permanent and increased when attempt is made to work. Tension, smarting, photophobia and occasionally phosphenes, dimness of vision are felt, but it is the pain etc., which compels the patient to desist from work, often for months. Apparent Asthenopia often occurs in Myopia, and occasionally in hyperemia of the optic disc and retina, and is termed hyperaesthesia of the retina if no organic changes are discernible. Asthenopia arising from weakness (“insufficiency”) of the internal recti muscles—by some termed muscular asthenopia, is often met with in Accommodative Asthenopia, and is sometimes mistaken for it.

INSUFFICIENCY OF THE INTERNAL RECTI MUSCLES.

INSUFFICIENCY OF THE CONVERGING POWER OF THE EYES—ASTHENOPIA MUSCULARIS.

“In Insufficiency, the associated movements of both eyes are normal—not so in Paresis.” Insufficiency of the internal recti muscles signifies want of power in these muscles. The subjective symptoms of the insufficiency are, in a great measure, those of asthenopia, and in every case of asthenopia, we should ascertain the power of the internal recti muscles. The asthenopia caused by insufficiency, is termed muscular asthenopia. The weaker eye diverges first. We suppose the insufficiency to be pretty equal, if, at one moment one, at another the other eye, diverges.

SCREEN TEST.—If we find that the excluded eye diverges, we infer that the converging power of that eye is insufficient. By Von Graefe’s test, it is further established. If, before the prism with the angle upward (which causes the dot and line to double) a second prism with the refracting angle outward, will measure the degree that will unite the two images. For Insufficiency at a distance, use the flame of a candle and determine the prism that can be overcome by convergence, and what prism can be overcome by divergence. The power of divergence, in these cases, is generally greater. Weakness of these muscles is often congenital and hereditary.

TREATMENT.—“Asthenopia, whether true or apparent, is a symptom, which, as a rule, subsides under proper treatment of its cause.

CORRECTION OF THE REFRACTION.—In insufficiency, we often succeed in removing the asthenopia, caused by it, through optical or surgical means or by combining of the two. In case the refraction is normal and the eyes are otherwise healthy, if divergence exist to the extent of 1° or $1\frac{1}{2}^\circ$, we recommend prismatic spectacles with refracting angle turned outward. "The external recti must be made to contract, and the internal ones to relax. "If, as in paresis of the internal recti muscles, it is desirable to excite and practice contraction of these muscles, we reverse the position of the prisms." We give prisms of equal strength to both eyes. If the strength of the correction exceeds 10° or 12° , we divide the external rectus of the eye, which diverges most on exclusion." We divide both external recti muscles, if, in each eye, the outward movement exceeds 60° . He explains decentering of lenses.

OPERATION.—The object of operation is to facilitate the contraction of the internal recti muscles.

The prominence of the German works in former years, and especially those translated by our well known American, Dr. Roosa, makes it necessary that their thought on the sunbject of Astheopia, in relation to the Function of Vision, should be represented in its history.

1868

CARL STELLWAG VON CARION, M. D.

Professor of Ophthalmology in the Imperial Royal University of Vienna.

TREATISE ON THE DISEASES OF THE EYE.

Translated by

CHARLES E. HACKLEY, M. D.

Surgeon to the New York Eye and Ear Infirmary, Physician to the New York Hospital, Fellow of the New York Academy of Medicine, etc.

D. B. ST. JOHN ROOSA, M. D.

Clinical Professor of the Eye and Ear in the Medical Department of the City of New York, etc.

ASTHENOPIA.—“By Asthenopia, we understand the inability of maintaining the adjustment of the dioptric apparatus, or the visual axis for short distances, for a length of time, and the hyperaesthesia of the retina and ciliary nerves accompanying this inability.”

The cause of the disease is sometimes an absolute or a relative deficiency of energy in the muscle of accommodation; at others it is a similar affection of the internal recti on which depends the convergence of the optic axes. Accommodative Asthenopia is most frequently seen. When the functional stamina has much decreased, and pain arises with swimming, they announce themselves by a feeling of fullness in the eye, with peculiar tension in the forehead, then over the eyes; soon dizziness, headache, malaise and even

nausea, almost always injection of the conjunctiva; episclera as well as lachrymation. Muscular asthenopia is much less frequent. The subjective symptoms are similar to those of the accommodative form; only the retina does not have to contend with circles of dispersion. Patients complain more of the neighboring letters running together and through each other; this is preceded by a straining sensation. Double vision occurs, assistance comes by removing objects to a greater distance. Many patients prefer to shut the weaker eye or move the object to the affected side, diminishing the amount of action required of it. "In muscular asthenopia a long interruption of work, or nightly rest does not suffice to produce an increased duration of function; the energy of the internal recti, once decreased, is again aroused with much more difficulty, and more slowly than that of the muscle of accommodation." On fixing at a near point, one eye becomes uncertain and finally turns outward. In tests of double image caused by prisms, there are crossed images produced. In emmetropes myopes, accommodative asthenopia rarely occurs, but such eyes are not perfectly safe when there is muscular insufficiency. The internal recti are most called on in high grades of myopia, hence muscular asthenopia principally affects the near sighted. Muscular asthenopia occurs more rapidly if there is also a congenital or developed deficiency of energy of the internal recti. These insufficiencies often occur and, as they are not combined with great myopia, it shows that muscular asthenopia may also, under certain circumstances, occur in slightly myopic or even emmetropic or hypermetropic persons. This would be practically liable to occur, when an unaccustomed strain of the muscle of convergence offered the opportunity. At first, symptoms appear when the affected muscle is subjected to unaccustomed straining. With continued forced work, the nervous symptoms soon become permanent—dazzling even, in slight use of the eye as in distant vision, exciting severe pains in and around the eye. The asthenopia acquires, more and more, the character of *retino ciliary hyperaesthesia*.

CAUSES OF ASTHENOPIA.—Among the causes of asthenopia, he gives the doctrine of Von Graefe. "The overburdening of the muscle of accommodation or of the internal recti. Frequently such insufficiencies are congenital, or even hereditary—hence affect unproportionally, members of the same family, and unfavorable circumstances almost always occur if the patient strain his eyes too soon. Hypermetropia furnishes by far the greatest number of cases of accommodative asthenopia. Muscular asthenopia

principally affects the near sighted, because the near approach of the object and the position of the point of rotation overburdens the converging muscles. This excessive work, imposed on the internal recti of very short sighted persons, who are employed with small objects, does not always produce muscular asthenopia, because the error of refraction generally increases and the energy of the muscles increases as the tendency to asthenopia diminishes. Later in life, posterior staphyloma increases rapidly. Muscular asthenopia occurs in congenital or developed deficiency of energy of the internal recti. These insufficiencies often occur, under certain circumstances, in slightly myopic or even emmetropic or hypermetropic persons. Eversion seems to be limited from parallelism; voluntary adduction always remains in excess. If there is insufficiency of one or both internal recti and consequent asthenopia, abduction is favored. At the distance of the ordinary occupations, much stronger prisms can be overcome, when the angle is outward than when it is inward. Even when the distance is greater the abduction still preponderates, so that quite strong prisms can be overcome, when the angle is outward, while even weak ones, with the angle inward, excite unbearable diplopia. A prism of 24° , angle inward, overcomes at ten inches, but with this angle outward 30° , and if the lateral deviation were 80° , there would be only a slight tendency to muscular asthenopia, as the insufficiency is only one third of the abduction.

"Among the special causes of muscular asthenopia, are sudden and powerful disturbances of the associations existing between the innervation of the muscle of accommodation and the lateral muscles of the eye ball." They will arise with some, who are accustomed to glasses and take them off; or in putting them onto those not accustomed to any. The muscle of adaptation is compelled to exert or relax quite differently, than was formerly required, with equal convergence of the optic axes. The disproportion is not endured and fatigue comes and soon asthenopia.

"It is a probable supposition and confirmed by careful observation, that insufficiency of the external recti, with asthenopia, may also occur."

COURSE AND RESULTS.—Asthenopia is capable of cure. It is especially true of those cases in which it is not so much an actual want of energy, that causes the disease, as an absolute excess of required action, and of those cases in which diseases and the general and local weakness they cause, have diminished the working power of the eye, and so placed the cause of the asthenopia in connection

with overburdening. Where a certain deficiency of energy is the cause of the development of asthenopia, the eye never returns to normal duration of function. Throughout life it requires certain helps, which in ordinary occupations, diminish the amount of work to the existing power.

The translator adds, "that under the belief that in asthenopia there was often a discrepancy between the power of the ciliary muscle and the angle of convergence, it was concluded that there was—1st. Some disturbance of the relative accommodation. 2d. There seems to be a want of tone or power of the ciliary muscle for continued action. 3d. Want of mental energy, the patient having lost confidence in his power to use his eyes.

He then describes Dr. Dyer's method of discipline, explained in this digest.

The work of J. Soelberg Wells, has figured largely, for a certain period, in Ophthalmology in this country. The clear and easily comprehended expressions of the text is one of the valued remembrances of its use, and the advanced course in the particular subject, which is our present study, is another cause for finding a niche for it in our history.

1869

A TREATISE ON THE DISEASES OF THE EYE.

American Edition.

J. SOELBERG WELLS.

Professor of Ophthalmology in Kings' College, London. Ophthalmological Surgeon to King's College Hospital, and Assistant Surgeon to the Royal Ophthalmic Hospital, Moorsfields.

ASTHENOPIA.

ACCOMMODATION.—Hypermetropia is a very frequent cause of asthenopia. This accommodative form of asthenopia must be distinguished from the muscular, which depends upon the weakness of the internal recti muscles, and also from the retinal asthenopia. The latter is generally due to hyperaesthesia and irritability of the retina, accompanied by hyperemia of the optic nerve and retina." "It mostly occurs in feeble, nervous and excitable persons—especially females."

MUSCULAR ASTHENOPIA.—This affection is of common occurrence, and is characterized by very marked symptoms of Asthenopia, which sometimes prove so irksome and harassing to the patient as to incapacitate him for reading etc. Such patients complain, that, after they have been working or reading for a certain length of time, the letters become confused and run into or overlap each other.

This is generally preceded by a feeling of tension or weight, in the eyes and over the brow, and some patients distinctly feel how the one eye becomes unsteady and wavering, and then moves gradually outward. They also anticipate these symptoms by closing one eye. After resting for a short time, reading may be resumed, to be, however, again interrupted by the same train of symptoms.

He measured the deviation of the lateral muscles, at a distance as well as near, by the use of a prism. with axis vertical, This, he says is a much more delicate test than that of covering one eye with the hand, for it will enable us to detect degrees of deviation of the optic axes, which are too slight to be appreciated by the eye. He gives the dot and line test of Von Graefe. After the presence of insufficiency and its degree have thus been determined, he tests the relative strength of the external recti of each eye, by ascertaining the strongest prism, which it is able to overcome at a distance of from 6 to 10 feet. He says, "Place prisms of various strength before one eye, turning the base, first outwards in order to find the strongest, with which a patient sees singly, and this gives the strength of the internal rectus. The external rectus of the same eye is to be tried, and the other eye should be examined in the same manner. Insufficiency of the internal recti is most frequently met with in cases of considerable myopia, but a temporary insufficiency of the internal recti may also be produced by severe constitutional diseases, which greatly weaken the system. It may co-exist with hypermetropia, and it should always be suspected if the symptoms of asthenopia persist, in spite of the use of convex lenses.

"The internal recti may be strengthened by frequent exercises with prisms (whose base is turned outward). The object (a lighted candle, white wand, etc.) is to be placed at a distance of 6 to 8 feet and a prism with its base outwards should be held before one eye. Crossed diplopia will be produced, and in order to overcome this the patient will squint inwards. The strength of the prism may be gradually increased but should not be too strong at first, otherwise the internal rectus will be weakened by over-exertion."

STRABISMUS.—The nature of strabismus is totally different from that of the paralytic. In the latter, the innervation of one or more of the muscles of the eye ball is impaired; whereas, concomitant squint is due to a change—an increased degree of tension in the muscles in the direction in which the squint occurs, but its innervation is normal, as is at once proved by the perfect mobility of the eyeball in this direction, and by the fact that the secondary

deviation exactly equals the primary, and does not exceed it, as in the case of paralysis.

TREATMENT.—As Hypermetropia is the most frequent cause of convergent squint, Myopia is the most frequent cause of divergent squint. He advocated operation, and recommended prismatic lenses to aid the internal recti; correction of hypermetropia with convex lenses, and corrected myopia with concave lenses, and decentering of lenses to aid the muscles.

Dr. Noyes of New York was a conspicuous figure in the dissemination of the science of Ophthalmology by his writings, teachings, and clinical work. He added many devices and improvements in instruments and facilities in ophthalmological work—and displayed a genius in systemization and the making of new applications to conditions, which he differentiated in his study of cases.

1875—1890

HENRY D. NOYES, A. M., M. D.

Professor of Ophthalmology and Otology in Bellevue Hospital Medical College; Executive Surgeon to the New York Eye and Ear Infirmary, etc.

**PAPER IN THE TRANSACTIONS OF THE INTERNATIONAL
OPHTHALMOLOGICAL CONGRESS. 1876.**

ASTHENOPIA.—In his analysis of 1079 cases of Ametropia and Muscular weakness with deductions respecting asthenopia, at the Congress, he notices the difficulties of authors in cases of asthenopia, which do not come under the category of Donders' or Graefe's systems, but are thrown out as "apparent" or "false" asthenopia. He uses the "word asthenopia as a generic term and not as being itself a disease." The cases of opacity of the cornea, incipient cataract, posterior synechia, a turbid vitreous or any slight retinal or charoidal affection may cause asthenopic symptoms, but these are placed in their true category. As in Amaurosis, Asthenopia is a generic term. "The word has become current as a generalization to distinguish those cases in which the use of the eyes causes pain or difficulty, and this when there is no ideopathic inflammation nor any opacity of media."

We condense his recital of the symptoms.—

SYMPTOMS.—1st. The cardinal symptom is pain, acute or dull, on efforts of use of eyes, near or remote, aggravated by bright light; it may be called by different names; “aching,” “a tired feeling,” “weariness,” “soreness,” “inability to look at anything,” “a horror of print,” “acute pain,” “dull pain,” etc. The seat may be in the eyeballs, supra-orbital or deep in the orbit; in the inner or outer angles, forehead or face, headache; sometimes any movement or fixation of the eyes is painful. Looking at rapidly moving objects, either when passing or riding. The most common occasion of pain is looking at near objects. Pain is produced by moving the eyes across the page, and by looking up or down to extreme lateral positions.

2d. Next in frequency comes smarting of the eyes as of foreign body under the lids; sometimes lachrymation. To relieve the feeling, patients rub or press on the eyeballs and often suppose the slight inflammation to be the cause of distress. Physicians, too often, so regard it, and prescribe without making deeper inquiries. This irritation has been noted by Donders and others. In my practice I find it noted in 158 cases. Under conjunctival irritation is included blepharitis ciliaris, blepharitis angularis, hordeola, cystic tumors and phlyctenulae as well as congestion of the palpebral or ocular conjunctiva; all these conditions are extremely prone to attend upon asthenopic troubles, which, sometimes, will not yield to any treatment, local or general, until the asthenopic symptoms (causes) are removed. These symptoms should be a sufficient presumption to cause inquiry into the functions of the eye.

3d. Blur or confusion or indistinctness in reading, writing, etc. Blur or indistinctness characterizes refractive and accommodative asthenopia and double vision, muscular asthenopia.

4th. There is always inability for or discomfort under sustained effort at near objects.

5th. Headache. In refractive errors—especially in astigmatism, it may be of constant or frequent occurrence and independent of use of the eyes. In other cases, it is caused by near work, and this is the most frequent in the two divisions of asthenopia. There are concurrent signs of congestion of the brain and spinal cord, such as dizziness, a sense of fulness and oppression, slight numbness of the upper extremities, tenderness over the spinous processes, etc.

6th. A symptom, correlated to headache is nausea; noted in four cases. They were instances of both refractive and muscular errors.

7th. Intolerance of light varies in every degree. Extreme cases are apt to be adjudged to have acute retinitis and grave vatiocinations are given. He details several cases of intense photophobia. He had had six with twitching of lids, seven facial spasms, and eight vertigo.

8th. Irregular muscular action in the muscles of the face. Sometimes, the ocular disability was found in ammetropia, and sometimes muscular. The ocular disabilities were relieved but the nervous spasms continued. He had not been able to discover any casual connection between asthenopia and chorea.

9th. Strabismus convergens, as one of the symptoms of asthenopia, may be considered illogical, because it is commonly a device in which the painful action is avoided. The hypermetropic, who squints, voluntarily thereby uses his eyes without fatigue, but if he does not squint he speedily becomes tired. He finds seven cases of strabismus convergens with myopia.

10th. Twice I find it noted that there were attacks of total darkness, lasting but a few minutes.

11th. Objective examination interiorily, showed, almost as a matter of course, there was hyperemia of the optic nerve and retina. There is a state of the nerve which could be pounced upon by "cebro oscopiats" as evidence of head trouble, unless there are signs of infiltration and swelling and opacity of the nerve, the fact of hyperemia counts for very little.

12th. The acuity of vision in asthenopia may be perfect or imperfect: does not exclude refractive error, nor in imperfect vision does not always admit of full correction.

ETIOLOGY.—As to the etiology of asthenopia, he says, old writers dwelt upon the influence of impaired health exerted upon the working powers of the eyes and this must be recognized in some cases as the essential and only cause, but in a great majority of cases, the ill health is but the exciting, and not the essential cause. The controlling cause lies in local disturbances; of these the larger part is refraction and muscular errors; they are found in conjunction; there are cases, however, of pure refraction and also cases of pure muscular trouble; a few paresis of accommodation. Another class of cases is found with irritation of the cervical part of the

spinal cord and base of the brain. Another subdivision, the sequel of nasal catarrh. In an immense majority of cases of asthenopia an adequate and intelligent cause can be found.

I have found hypermetropic astigmatism in small degrees, of importance to correct.

MUSCULAR.—In muscular trouble, I have been helped out of perplexity by finding small deficiencies in the externi or in the movement of the globe in a vertical direction, in maintaining an extreme position; so too, the fact that there is a rotary motion on the horizontal movement, unsteady and jerky. There need be nothing like *nastigmus* or *diplopia* and there may or may not be refractive errors.

HYPERAESTHESIA.—He believes that a few cases of hyperaesthesia of the retina are too often assigned as the primary lesion in undue sensibility of the retina, or the neuralgia of the nerves of sensation are used to cover up imperfect examinations. The correction of small errors is not always attended with happy results. Repose is needful, sometimes entire discontinuance of work for a time. I very rarely give this advice; the moral effect is not good.

All oculists practice the advice of Dr. Dyer. It takes from one to six months to cure, and very many have been cured by this process.

MUSCULAR ASTHENOPIA.—The muscles *recti interni* are so frequently the pair at fault, that the occurrence of weakness on other muscles is liable to be overlooked.

Next, in order of frequency, come cases in which all the muscles are deficient. Next come the *recti externi*, and lastly, cases in which the movements of the eyes, up and down, are irregular—excluding *nastigmus*.

TESTS.—He uses Graefe's test for insufficiency, but prefers a white dot on a black surface to the dot and line. Of late had been taking the power of adduction and abduction at 20 feet, it being more reliable than in the association with accommodation. Among the emmetropic, the muscular power is much below standard and varies as the tone of the general health.

"It has been my observation that very few persons can get along comfortably with less than 20° adduction for 20 feet distance and 4° to 6° abduction. "These cases have been little regarded, because the share which the muscles contribute to the discomfort of myopes, has absorbed the ophthalmic attention."

ASSOCIATION OF ACCOMMODATIVE AND MUSCULAR ASTHENOPIA.—As a rule, patients with hypermetropia suffer from accommodative asthenopia alone, but the combination with muscular asthenopia is not impossible. The addition of a glass to the eye changes the muscular equilibrium and usually develops a higher degree of insufficiency than without glass, but the inaptitude may soon disappear.”

SPASM OF ACCOMMODATION.—He gives a series of cases of spasm of accommodation, provoked by weakness of the interni, associated with Myopia and Astigmatism. He also gives a number of cases, whose external recti are at fault, with asthenopia with no converging strabismus; some with pain, some intolerance of light, others conjunctivitis. He found a few cases where the failure of equilibrium was from verticals. His means of diagnosis was not that which we have. He reports a large number of cases where all the muscles were enfeebled. Half were emmetropic. Fixation and movement showed tremor, and they exhibited the symptoms of asthenopia in an exquisite degree. Some had a horror of looking at objects, and mind especially morbid. Some were emmetropic; some had equilibrium.

Dr. Noyes finds, that out of 227 cases of *muscular asthenopia* 172 were of the recti interni; 24 of all the muscles; 16 of recti externi; 15 of oblique, supra and infra.

There was insufficiency of recti interni with 60 of E.; 30 of H.; 56 of M.; and 26 of astigmatism.

TREATISE ON THE DISEASES OF THE EYE (WOOD'S LIBRARY). 1881.

A TEXT BOOK ON THE DISEASES OF THE EYE. 1890.

ASTHENOPIA.—In Dr. Noyes' "Diseases of the Eye"—Woods' Library Edition (1881) he uses the word asthenopia, but he does not head a chapter with it or make it a distinct disease, and the word does not appear under Accommodation, but it is made prominent in his later work, "Diseases of the Eye" (1890) where he devotes 20 pages to it, in two of which Accommodative Asthenopia is described, and in the subject of refraction it is mentioned, and not many of the symptoms are ascribed to the ciliary muscle.

CAUSES.—Among the causes of asthenopia, he says, "refractive errors—especially myopia which inclines to weakness of adduction, and hyperopia which inclines to weakness of abduction, and astig-

matism, are frequent and obvious causes. There may, however, be small errors, too trifling to account for the asthenopia, and the persons enjoy good health and good use of eyes until, without explanation, an acute breakdown occurs. "The person may be of exceptional vigor, and not have attempted more eye work than may be justly called reasonable, yet have severe pain in the eyes and head, sometimes vertigo and a sense of oppression and much ocular irritation." "The refractive error may be very small, and the only statement to be made is, that certain muscles, say the externi or the interni, are intrinsically weak. Frequently, operative causes are, depreciation of general health by chronic or acute diseases, pressure on the nerve twigs by inflammation, or thickening of their sheath, by growths, by injuries, or by congenital disorders; heredity is not infrequent. Overtaxation of the eyes is the important factor, and is brought about by reading on railway trains and in carriages; by reading when lying down, which convalescents and chronic invalids often find out too late, they should not do, by attempting difficult work, such as embroidery, sewing on black, fine painting, decoration of china, etc.; bending over work and bringing it too near the eyes; by the study of languages whose text is intricate, such as Greek, German, Hebrew, etc. Want of vigor, whether from congenital conditions of health; by too rapid growth, by malaria, by any debilitating causes, by shock, grief, etc.—all are to be duly considered—especially too, all forms of uterine diseases, hemorrhage, fevers, chronic anaemia, instigate muscular asthenopia. It will often happen that the depressing agencies mentioned are simply exciting causes of a disorder, whose real progenitor is an essential muscular weakness, which may long have been latent, but is now made potential."

MUSCULAR INSUFFICIENCY.—"It is important to make a distinction in cases of muscular insufficiency and those which are purely local, and those in which the defect is associated with general ill health. Symptoms of eye trouble may be simply the effect of remote disorders, on the other hand, eye defects can excite remote reflex troubles, and these quite disappear when the eye defects are corrected."

Under Muscular Asthenopia, he details most of the symptoms that are so graphically described by some writers, under eye strain.

"Cases of apparent congestion of the base of the brain, and tenderness over the middle and upper cervical vertebrae." To the previous enumeration of symptoms in the report at the Congress, he mentions the relief obtained by pressing the eye balls. Pain

in using or fixing the eyes is the conspicuous symptom. This appears in all kinds of near work, reading, writing, etc.; it may also exist in distant vision, in looking at a crowd, or at a stage in a theater, looking out of a carriage or from the window of a railway car, etc. There may be great photophobia. Pain is generally in the eyeball, but is often temporal, frontal, occipital or at vertex. In truth, not a small percentage of obstinate headaches, "especially ache on first awaking from sleep in the morning." Dizziness, and when the general health is feeble, or the subject neurotic; we may have the most erratic and intense remote symptoms; aphonia, palpitation of the heart, pain in the ovaries, diarrhoea, rectal irritation, etc. He here speaks cautiously of the hysteria, chorea, epilepsy and says, "I cannot deny that, in a few cases, eye strain may have been demonstrated to be an exciting cause or occasion, but there has been behind it a deep lesion of the general nerve system."

SPASMS OF ACCOMMODATION.—Under Spasms of Accommodation, (Wood's Library Edition 5) "It will very likely be found that the extrinsic muscles of the eye are also weak, they belong in the same reduced state as the ciliary muscle." "Moreover, the supposition of spasm is not to be excluded because of general debility. It also appears, together with other spasmodic afflictions, such as blepharospasm and nystagmus and again in cases of hyperaesthesia retinae."

"Spasms of Accommodation accompany many functional and refractive disorders of the eye." "It is the immediate cause of the discomfort of the great body of workers upon small objects, who complain of eye troubles." "In my view, many cases of Muscular Asthenopia are not evidences so much of the defective power of certain muscles, as of continued and excessive action or spasms of opposing and dominating muscles. Only in this view, can many cases of recovery by spasms and by slight tenotomies, be accounted for."

OBJECTIVE SYMPTOMS.—Under Objective Symptoms, after observation of the manner in which eyes behave under the test, with card first over one, then over the other eye, as to tremulousness and deviation from the median line, and carrying the object looked at close to the nose, and also their behavior in extreme positions to the right and to the left, and pronouncing these tests only suggestive, he begins with the real examination, correction of the refractive errors, visual acuity." Next the muscular conditions.

Regarding a candle flame at 6 meters with prisms, he makes the remark, "that it is decidedly preferable to take the muscular conditions at this remote point." Experience proves that the moderate degrees of Ametropia do not interfere with muscular tests. Beginning with abduction, he uses a battery of a series of square prisms, one above the other, with interval of 2° , one series with odd numbers and another with even numbers, 9 in each (preferring this to the revolving double prism as more reliable and less misleading) to ascertain capacity of the muscles. Besides this, for one eye, one may hold in the other hand a 5° interval, over each eye for adduction, and when this is exhausted, place 10° over each eye in spectacle frames and proceed with the batteries in front of them; can thus attain to 62° .

The strongest prism which can be overcome, that is despite of which the flame appears single, measures the duction of that pair. Less than 5° abduction is pathological. Adduction is made by reversing the base outward, being careful to avoid obliquity. Adduction should reach 25° to 50° , but the physiological limit is not well defined. More than one examination is necessary to decide what may be the patient's capacity. Next put before one eye a 5° or a 10° prism base [axis] vertical. Two flames appear, which ought to be perpendicular to each other. When prism is over L. E. with base upward, the lower image corresponds to L. E. If this appears to the left of the other as well as below, the condition indicates homonymous diplopia and weakness of abduction or of the interni. If the lower image goes to the patient's right, this means weakness of adduction or of the interni. The prism placed so as to bring the images into a vertical line measures the displacement, which Von Graefe called the insufficiency of the muscles, whether of the externi or interni. This phrase has acquired this technical meaning and is, to some extent, misleading.

He gives place to Dr. Stevens' terms in muscular anomalies. He had not found any absolute standard for adduction and abduction, nevertheless, a certain ratio must not be exceeded; and for distance for adduction 36° to 42° , abduction, 60° or adduction 40° to 45° , and abduction 70° which is about 6 to 1. For near 13 inches, adduction 40° and abduction 20° suffices for comfort.

Examination at working distance. Instead of Von Graefe's dot and line test, he uses a white dot on a black surface placed on a carrier on a central stem. Near the eye is a box containing three cells before each eye, into which square lenses can be dropped, which is more convenient than the trial frame. Sometimes a patient

cannot put forth his real energy when looking into an apparatus. Let him make a few trials without—holding the prisms in one hand and the test card in the other. Beginning with Von Graefe's equilibrium test, place a 10° with base (axis) vertical. If images do not stand vertically above one another, there is deviation in the sense of abduction. When about 5° only, this cannot be called abnormal, and directs suspicion upon the externi. Next try the abduction and the adduction suitably placed. Great diversities will appear, according to conditions of refraction; especially will weakness of adduction appear with myopia. On the other hand, abduction will more frequently be found in emmetropia hypermetropia, and astigmatism. Spasms of accommodation may be detected by slipping into the holder a 5° prism combined with a plus 3. D. base inward before each eye; placing No. 1 Snellen at 13 inches; if not read by emmetropes until it approaches to 9 inches, spasm may be inferred. With myopes, spasm sufficient to vitiate the test is not common, while with other ametropes proper corrections will be made.

A small number of cases exhibit symptoms of muscular asthenopia, which do not betray any notable fault of the externi or the interni, nor, if there be errors of refraction does its correction remove the symptoms. In such, search for errors in action of the muscles, which move the globe up and down. With correction of refraction on, light at 20 feet, use a prism base inward of 10° or 15° (be careful that the axis is perfectly horizontal) If the two images are not on a horizontal line, inquire which is the higher. The images are homonymous images because the visual lines are relatively convergent, and if the left is above the other the fault is in the L. E. and *vice versa*. If there is no vertical error, try what power the patient possesses for overcoming prisms with vertical axes. Begin with one degree and go up until the limit is reached. I have found them able to overcome 3° to 8° with no apparent deviation of visual lines. If a prism of 3° , with the base up before the eye, is easily overcome, it should cause very wide diplopia if its base is reversed; by thus testing each eye, we may succeed in determining which is at fault. For persons, who do not habitually and invariably practice binocular vision, as in some myopes and in cases of great anisometropia, etc.; this fault of vertical displacement of one visual axis, is exceedingly common, and does not occasion asthenopic symptoms. For them it is difficult to recognize double images, and if they do catch them, it may be only for an instant, even when they are brought into close contiguity. When the candle flame is seen obliquely, it indicates a fault with

one of the oblique muscles. We have six general muscular weaknesses for all distances.

We have symptoms of muscular asthenopia most frequently in cases where muscular groups are not properly balanced or proportioned. We may also have it when there is debility of the whole muscular apparatus without special disproportion among the opposing groups. It is not, however, an invariable rule, that general weakness of the eye muscles, of necessity, causes asthenopia. A large margin must be allowed for what may be called nervous excitability or activity. Those of quick, eager and vivid perceptions, whose mental processes are always lively and ready, are the persons most liable to complain. The torpid or deliberate persons are less often sufferers from muscular asthenopia. The young often suffer from this trouble.

Dr. Landolt of Paris, France has figured largely in contributions to American Ophthalmic literature during the last decade. He comes nearer to the views of Dr. Noyes of New York than other authors on the subject, in his conception of the relation of the focal apparatus and the motor apparatus, but did not reach Dr. Noyes' practical treatment of the muscular anomalies, which he found so abundant.

1886.

E. LANDOLT, M. D., PARIS, FRANCE.

THE REFRACTION AND ACCOMMODATION OF THE EYE.

Translated by

C. M. CULVER, M. A., M. D.

1900.

E. LANDOLT, M. D., PARIS, FRANCE.

**ANOMALIES OF THE MOTOR APPARATUS OF THE EYE.
IN SYSTEM OF THE DISEASES OF THE EYE. VOL. IV.**

Translated by

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REFRACTION AND ACCOMMODATION.

He explains the effect of glasses on accommodation and convergence as follows:

Convex glasses modify the relations between accommodation and convergence. A sudden exclusion of accommodation in order to fix the near object binocularly, he is obliged to make a consider-

able effort at convergence, while the accommodation must be totally released. At first the object is seen with crossed diplopia, because "the sudden exclusion of the accommodation disposes the eyes to assume a parallel direction, or at least renders convergence difficult." "They diverge therefore, relatively to the position of the object. Even when one has succeeded in uniting the double images, a certain disagreeable feeling often persists in the forehead and eyes and proves that the latter perform only with difficulty, this unusual and anti-physiological function."

Now, since the elasticity of the crystalline lens is diminished throughout life, the accommodative effort ought to increase proportionally, in order to produce the same number of dioptries, and, inasmuch as the amplitude of convergence, essentially dependent upon the strength of the muscles, does not diminish with the accommodation, but remains nearly stationary, the individual is forced to vary, in a physiological state, the effort of accommodation, which he associates with a given effort of convergence. "The 3 dioptries of accommodation, which an emmetrope must have, when fixing an object 33 C. M. distant, will require from him a much greater muscular effort at the age of forty than at the age of twenty years, while the effort of convergence will remain the same—3 meter angles. The difference is still more perceptible in the cases of hyperopes, especially of the medium or high degree; in the defect, static refraction of itself, determines a branch of the equilibrium between the two functions." "Convex glasses render inestimable service by relieving the accommodative muscle of a quota of its work by establishing between convergence and accommodation the relation most agreeable to the individual. Convex lenses can also exercise a direct influence upon convergence, by regarding them as two prisms with their bases joined. "An eye looking through a convex glass will see objects in their real position, only when looking along the axis of the lens, while they will appear displaced along the periphery of the glass on the side "through which the eye looks, when its gaze is directed away from the center, and they will appear displaced toward the periphery of the glass exactly as if they were seen through a prism." With a pair of spectacles for distance, when they look through the center, the object is not deflected, but if used for near visions the prismatic action is apparent, for on converging the eyes, the eyes look through a portion of the lens to the apices toward the nose and, in order to see without diplopia, the prism effect has to be overcome by an extra effort, and if the muscles are somewhat weak, it makes itself felt

even in lower numbers. "From four dioptries on, their influence on convergence ought never to be disregarded." In afakia the trouble is common. We must confess that our knowledge, as regards muscular asthenopia, and insufficiency of convergence is still in its infancy. The observation of the results of operations with a view to cure it, have been neither numerous nor in accord with each other.

INSUFFICIENCY.—"Insufficiency of the power of convergence is quite a wide spread affection and a frequent cause of asthenopia. It is not by any means peculiar to myopes only, even if they do, from necessity, at a near point, suffer more from it than others, and are, on account of the conformation of the eyes, more inclined to it." He distinguishes two forms—1st. "Muscular asthenopia in the true sense of the word, depending upon the absolute or rotative weakness of the adduction or upon their insertion." "The second has its origin in the central organ, and depends upon a disturbance of the innervation or upon the weakness of the power of fusion." "The excursions of the eyes, the monocular fields of fixation and the associated movements, may, with all this, be quite normal, while the amplitude of convergence is much reduced, even, at times, equal to zero. With a negative convergence or divergence, where spontaneous binocular vision does not exist, vision at a near point" can only be accomplished with the aid of abducting prisms. In all cases where the positive convergence does not reach nine meter angles, asthenopic troubles may develop, when the eyes are not used for near vision. The ideal correction would be realized by a lens large enough, that its periphery would reach over both eyes, or better, by cutting out the periphery, which would thus impinge over each eye for insertion into spectacles. The prismatic effect of spherical glasses also affects the vertical meridians—the position as to the base line is important.

Just as in the case of convex lenses, concave ones act as prisms if one does not look through their optical center. The lens being thinner in the center than at the periphery, the prism effect is opposite to that of the convex lenses. The prism effect, when the lines of fixation pass externally to the axes, will increase the effect of convergence (adducting prisms) the object being deflected outward, and the eye in correcting it, converges to get the image on the fovea centralis. On the other hand, when the eyes look through the inner halves of concave glasses, the latter will act like prisms with apices

turned toward the temples. Thus it is that the prismatic effect of concave lenses, by decentering, may render real service.

When the insufficiency of convergence has resisted hygienic measures, general strengthening treatment aids in gaining repose of the eyes, and when it is too great to be corrected by optical means, we may think of remedying it in a surgical way.

For paresis of accommodation, there is constitutional treatment, electricity, and the fitting of lenses.

TREATMENT.—Orthoptic training consists in the use of a "Wheatstone's Stereoscope." Upon the resistance of these methods, tenotomy of both external recti, advancement of the interni, or even a combination of both these operations is explained. In cases of "neurasthenic insufficiency," when amplitude of convergence is very narrow," we ought to be guarded in operating as well as in making our prognosis." An exercise is given in which the patient is seated, at least 5 meters from a lighted candle and directed to turn the head to the point, where there is a tendency of the lights to separate and he is directed to keep them fused. "The patient will, in this way, succeed in extending the domain of single binocular vision" after some weeks or months. Prisms may have to be resorted to.

"When insufficiency of the adductors has given way to a true divergent strabismus, and when the latter is still periodic, it may sometimes be remedied by prismatic and concave glasses, but such cases are very rare. The divergent strabismus which we meet with in practice has, long since, far exceeded the degrees that are corrigible by optical means." The surgical treatment is indeed, the only efficacious one in high degrees of insufficiency of convergence, and with all the more reason, in divergent strabismus.

ANOMALIES OF THE MOTOR APPARATUS OF THE EYE, IN SYSTEM OF DISEASES OF THE EYE.

After consideration of the ocular muscles, one by one, with reference to the movements of the globe and the phenomena which result from the paralysis of these muscles, he devotes a section to "Non-paralytic Strabismus."

A correct notion of the ocular movements "will be had by considering all the muscles, as together forming one motor apparatus." It can be seen that "each movement, given to the eye, encounters an opposite regulating movement." "There is no direction that the

eye cannot easily take, and in which it cannot remain without fatigue." The mechanism is more marvelous, "when combined movements of the two eyes are considered." Binocular vision requires that the two eyes be directed simultaneously toward the object looked at, so that it may fall on the fovea centralis of each eye, when the objects are fused into a single one. The impression is thus made vivid and a certain impression of distance and relief is given to it. The eyes diverge in a state of rest, but without an appreciable difference in height. Convergence is not an act among the lower mammals. When both eyes are not simultaneously directed toward the point to which the possessor directs his attention, strabismus is present. It is association between accommodation and convergence which can impress a proper direction upon an eye which is not fixing. If this association is not present the eye deviates, but will not, however, abandon the level of its fellow. Now, paralytic strabismus, sursum or dorsum vergens, is very rare, and never attains a degree comparable to that with which one usually meets in lateral strabismus. Unless muscular paralysis be present, one eye never moves alone but the second eye takes an active part in the motion and there is no divergence of one eye, as in paralysis of the internal rectus or convergence of one eye, as in paralysis of the abducens but there is divergence or convergence between the two eyes in the same degree. One eye fixes and the other eye takes position out of line, and this gives the appearance of a monocular deviation. The expression correctly made, would be—"the eyes diverge or converge—the right eye performing the fixation."

STRABISMUS.—"Strabismus is not always manifest. In its early stages especially, it sometimes remains latent, and shows itself under conditions of fatigue of the eyes or body; under influences of emotion or when binocular vision is suppressed by the exclusion of one eye." "When the vision of each eye is good, strabismus often passes from one eye to the other," the eyes alternating in fixing and yet do not see double. Generally, by using red glass over one eye, the patient can be made to see two images. By provoking diplopia in the vertical meridian by means of a prism (base down) he may be made to see two images, but it may be difficult for him to determine whether they are homonymous or crossed. In paralysis this is not the case. "The image of the deviating eye is sometimes systematically disregarded by the visual center." One can discipline himself into the same analogous condition, as in the use of the ophthalmoscope or microscope—

having both eyes open in the use of these instruments, and ignoring the image received by the eye to which he is directing his attention. This phenomena is called, "suppression or exclusion" of the images of the deviating eye.

REGIONAL EXCLUSION.—There is such a thing as regional exclusion—a part of the retina only in which there is suppression, and by imposing a prism of double vision, it can be provoked and can then be measured. In the horizontal direction stronger prisms are required than in the vertical direction, to accomplish this. The entire retina may have exclusion over its whole surface and this is *total exclusion*.

Not rarely, a kind of new identity between the two retinae is established. The part of the retinae of the affected eye, which receives the image of the object, assumes the function of the macula and the visual impression is fused with that of the healthy eye. Weak prisms suffice to produce diplopia in *these cases* even when prisms or mirrors are placed to throw the image on the macula of the deviating eye, double images are produced.

The long duration of strabismus is the cause of the change in the correspondence of the retina, and after correction of the strabismus, the diplopia produced by the change, through operation, almost always disappears. The stereoscopic effect may be restored if the patient will patiently carry out the necessary exercises.

NON-PARALYTIC DIVERGENT STRABISMUS.

After describing the different etiologies, held by authors in regard to Convergent Squint, Landolt says, "Examination of the field of fixation has taught us the fact, already pointed out by Donders, that the temporal excursion of both eyes is almost always restricted in convergent strabismus. "This defect in motility, which is often not very pronounced in recent cases, is the rule for cases of long standing. It is always found in both eyes, and often in the same degree. Frequently, it is more developed in the deviating one than in the fixing one." "Those who are given to the performance of muscular advancement, have abundant occasion to verify the weakness of the external recti muscles in cases of convergent strabismus. These muscles are thin and flabby, especially in comparison with their antagonists." We have to inquire whether it is primary or secondary. It seems to us that this defective development of the abductors is due to a lack of use. The excu-

sions of the eyes, before we change directions of our faces, are in R. or L., 3° or 4° —elevation 3° , lowering 5° . This shows that no demand is made at all comparable with that made on the internal recti in convergence.

CAUSES OF MALFORMATION.—Enumerating causes of malformation as local changes in the muscle, (congenital weakness, vicious insertion, anatomical shortening) spasms due to Keratitis, which many authors consider the cause of convergent as well as divergent strabismus, Landolt thinks has been exaggerated, but does not deny the possibility of such malformations, yet why should the ocular muscles be exempt from the infirmities, which are met with in all the other muscles of the human body?

After reviewing the different authors as to the cause of the deviation in convergent strabismus, he expresses it thus, "By contracting too much, the internal recti have become unable to relax entirely, or exaggerated convergence becomes habitual." Thus, on account of secondary anatomical changes, muscles, which at the outset were normal, become altered in their functions. "Nothing," he says, "is more difficult than to determine the position of minimum innervation of the ocular muscles." "It would be of no great advantage if we could." It is the consequence of the influence of a number of factors, which act upon the relative direction of the eyes."

"The inanity of the muscular theory of squint having been shown long ago, one hears it said, upon different sides, that it has been replaced by a new theory, "the central or nervous theory." These words have no significance of themselves. Donders' theory of the intimate relation of convergence and accommodation, in their connection, in the central nervous system, where the fusion of the two muscular impressions takes place, in the sensation of binocular vision, has the great merit of its explanation here." In the light of more recent physiology, he says, "the attempts to localize strabismus in the central organ, do not mean that it is to be considered as a cerebral affection, although, in some general diseases, there are changes in the centers of innervation. If one squints toward the nose without being the victim of paralysis of the abductors, it is because his abductors are not held in equilibrium by these muscles—because the former contract too much—the latter too little, and since they contract only under the influence of a nervous impulse, it is evident, there must be an absolute or relative excess of the innervation for convergence. *Why*, the center of

convergence shows itself so exuberant in convergent strabismus, and *why*, in divergent, the center fails to do its duty, is to be explained. "Donders answers this question satisfactorily in the immense majority of cases of strabismus"—mentioning the occasional cause of its development, he discusses fixation at the near point, when they sometimes accidentally discover that they can secure distinctness of vision by sacrificing the use of one eye. He gives instances of persons curing themselves of strabismus by acting on the contrary muscles through the will.

Hyperopic, convergent strabismus, generally commences by being periodic or alternating. It is often, at the outset, also relative—localizes itself in one eye, generally the weaker one.

LANDOLT'S TREATMENT OF CONVERGENT STRABISMUS.

"When due to defects of refraction, which necessitates an exaggerated effort of accommodation. Conner's glasses are indicated and mydriatics. The necessity of correcting the vision of the inferior eye by correcting the astigmatism and restoring it to visual power by exercising it, and still more important are the exercises, which bring into action both eyes simultaneously for the purpose of stimulating or re-establishing binocular vision. The principal cause of strabismus and the greatest obstacle to its cure, being the absence of binocular vision—it is evident that anything, which tends to re-establish the fusion of the retinal impression of the two eyes, constitutes a valuable therapeutic agent in the treatment of the infirmity. To secure relaxation of accommodation, it is necessary to have recourse to Mydriatics. He advocates the use of Javal's stereoscope in the fusion of images for the cure of strabismus.

SURGICAL TREATMENT OF CONVERGENT STRABISMUS.

He advocates advancement instead of tenotomy. It is best to continue orthoptic treatment for a long time. The most perfect surgical correction is not always sufficient, even if the vision is good in both eyes. The eyes have forgotten—if they have ever learned—to fuse the impression of their foveas.

In divergent strabismus, the false image is carried toward the temple—homonymous—and treatment is required for this, after operation.

NON-PARALYTIC DIVERGENT STRABISMUS.

As a rule, the eyes diverge in complete repose considering the divergence of the orbits. The function of convergence is only found in the higher order of vertebrates, diverging the more as we descend in the examination until we find in fishes that they are 90° to each other. "Convergence in man is so intimately associated with accommodation, that, under normal circumstances, an effort of accommodation suffices to provoke a convergent movement." Without either of these, divergence almost invariably takes place, and this explains why, an amblyopic eye deviates toward the temple, and why myopes, who exercise their accommodation much less than emmetropes, and hyperopes, furnish the large majority of divergent strabismus. The ellipsoidal form of the myopic, favors this position. In high degrees of myopia, from the necessity of bringing the object so close they are apt to give up convergence, and allow the eye, not used, to diverge. Binocular vision is not developed and the visual impression is suppressed in the eye, not fixing, in order not to be troubled with double vision. Divergence is mostly absolute, existing for all directions of the gaze. This condition very often occurs in cases of myopia of less degree. The alteration of accommodation and convergence undergoes considerable change from that in emmetropia. He sees without any effort at accommodation, at a distance for which he is obliged to use a great amount of convergence. There exists an *insufficiency* of convergence. Up to 5. D. of myopia, the independence of convergence relatively to accommodation, can be estimated, if the amplitude of convergence is sufficiently developed for binocular clear vision. If there be added to defective development, enfeebled motor muscles, from debilitating illness, the individual will only too promptly abandon convergence, and let the inferior eye turn out. "Thus we see that typical convergent strabismus—that of Hyperopes—is an active—a spastic strabismus." "Divergent strabismus is an essentially passive strabismus, due to a relaxitive or a lack of development of convergence."

"Although myopia, for the reasons stated, furnishes the largest proportion of divergent squint, yet it is also found in other states of refraction." Any cause which abolishes binocular vision predisposes to strabismus. Divergence is found in the position of repose. "It is for this reason that divergence is the rule in monocular amblyopia or amaurosis." Fixing with the best eye, the deviation manifests itself in the amblyopic one. "Divergent strabismus

is a binocular strabismus, just as is convergent strabismus." "In the same way, as the examination of the field of fixation denotes, in convergent strabismus of long standing, a limitation of the temporal excursions of both eyes, so the excursions toward the nasal side are always found limited in both eyes, although only one, and always the same one, is the victim of divergent strabismus."

"This defect in motility is, in both cases, and in the majority of instances, not the cause but the consequence of strabismus." In divergent strabismus, it is due to a lack of use of the abductor muscles, for which convergence contributes an exercise much more powerful than do the associated lateral movements. Considering that "there is nothing absolute in the relations between accommodation and convergence," "one cannot admit a single center of innervation as ruling them simultaneously." "This independence of relation is shown by the fact that the amplitude of accommodation gradually diminishes, as age advances, until it becomes nil, while convergence remains almost invariable during the whole lifetime—hence the relations between the two functions must be continually modified, otherwise binocular and distinct vision would not be possible, even for emmetropic eyes." "The individual must learn how to associate the same degree of convergence with a greater and greater (less and less) degree of accommodation."

As long as the emmetrope fuses well the visual impressions of his two eyes, accommodation causes him to converge so correctly that he directs even the eye that has been excluded from vision, toward the object fixed by the other, but if he loses the sight of one of the eyes, he learns equally well to abandon the effort of convergence," and as the insufficiency is no more troublesome than when he had double vision, it is natural that convergence should be almost entirely lost. It may equally happen with hyperopes, which augments convergence in order to facilitate accommodation. "Not all, however, have convergent strabismus. Some of them, deprived of binocular vision, squint outward and furnish a certain contingent of (5 per cent) of divergent strabismus." "As in convergent strabismus, local circumstances have been given as a cause; vicious insertion, a defective development, an insufficient power of the abductor muscles or the excessive separation of the orbits, and smallness of the angula gamma."

Stilling and others say, "certain eyes ought to be predisposed to divergent strabismus by their position of equilibrium, which in this case is divergence." "Another theory holds that it is a pri-

mary lesion of the centers controlling the symmetrical movements of the eyes.”

Concomitant divergent strabismus, which it is necessary to distinguish from paralytic strabismus—The first is equality of the conjugate movements of the eyes, and the gradual development of the deviation, etc. There is a well defined diplopia increasing in one direction and diminishing in the other, leaving no doubt of paralysis. This diplopia is the most striking symptom of paralytic strabismus, but in it there may be amblyopia in one eye, which excludes diplopia and the certainty of diagnosis is made by other symptoms. In this concomitant divergent strabismus, the divergence manifests itself only under certain circumstances (“relative”). On looking into infinity the eyes may be in equilibrium and they may follow the object as it is brought nearer, but at a certain point they stop converging, the eyes waver and if brought still closer, one eye diverges, and double vision is the consequence, although the patient may describe it as confusion. The beginning of divergence or insufficiency may be accompanied with asthenopia, headache, vertigo and visual disturbances. This initial stage of divergent strabismus may endure for months or years. In myopia of high degree, especially with amblyopia in one eye, the relation becomes absolute strabismus.

INSUFFICIENCY OF CONVERGENCE.

There has been a recognition of asthenopia caused by insufficiency of the interni, but Krenchel in 1873 clearly established that convergence must be considered a function by itself, which can be altered without lesion of the muscles which produce it. He and others gave support to it so that insufficiency of convergence is now considered as a well defined entity.

Landolt here defines, “convergence as the faculty of directing the two eyes toward the object of fixation, whether the object be situated at a definite distance or infinite, or even beyond infinity”—that is to say, whether its fixation requires actual convergence, parallelism or divergence.” He describes the system of Nagel of the meter angle. He has a method of representation of maximum and minimum, both positive and negative. See figure. Eyes can diverge one meter angle—about 3.5° , or 3.5 centimeters. The negative convergence is above the zero line, and the positive below the line. The normal amount of convergence ought to be 9 M. a.

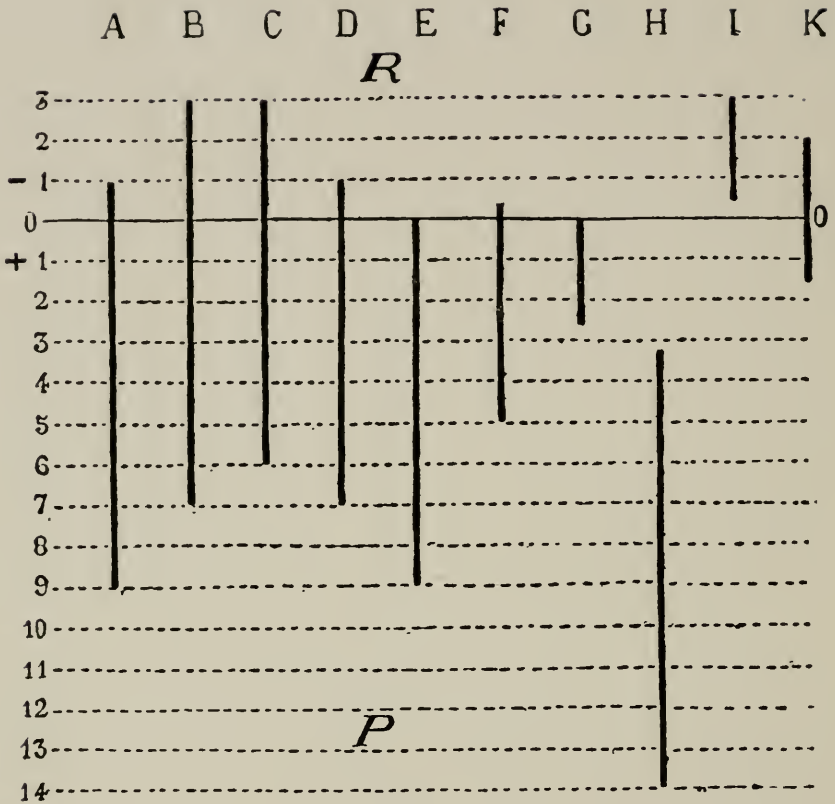


Fig. 1.

In figure Amplitude is represented; the full horizontal line indicates zero or parallelism; the part above the horizontal line represents the negative convergence and the part below the positive convergence.

In A there is normal negative and positive. In B there is a total of 10 M. a. and yet there is insufficiency of convergence—that being but 7 M. a.—the 3 M. a. are negative. In C there is the same negative and less positive. In D there is only a little short of the positive. In E the amplitude is all positive. In F, C and K, convergence is all negative. His adduction does not bring him to his parallelism.

The punctum proximum represents the maximum of convergence of which an individual is capable, but he can maintain neither accommodation nor convergence more than an instant at this point. This then is not the distance at which the individual can work. He must have a certain amount of force in reserve for his working point.

The quota of convergence in reserve should be twice as great as the convergence required for the work. To work at 3 M. a., there should be 6 M. a. in reserve—9 M. a. in all. In spite of the normal amplitude, convergence may be insufficient for exceptionally near work, and those deficient in it will find fatigue, because there is diminution of the positive part. The negative has to be expended to get parallelism and the remainder of the amplitude the positive. The punctum proximum is too far away and convergence gives rise to those symptoms of asthenopia, which are encountered in the early stages of divergent strabismus—viz., the fatigue of the eyes, crossed diplopia, pains in the head, having their seat especially in the forehead, vertigo, and general malaise.

Insufficiency may have a cause in lesion of the brain or spinal cord—*tabes dorsales* locomotor ataxia and affections of the nervous system. A different form of insufficiency is that which accompanies neurasthenia. He finds it as a cause in women and men, and that in men of splendid and remarkable strength—with two good eyes but not able to use them at short distance. It also accompanies anaemia, the sequel of typhoid influenza, accouchement, etc. This form he denominates as central because of lack of energy. In those from *lack of use*, as in myopia, divergence coming because one of the stimulants, accommodation, is lacking. Although they may have amplitude of convergence it is inferior to emmetropes, and there is excess of abduction, and lack of exercise, but there is in no wise a paralysis.

As in the case of an equestrian, who is not in practice and is easily thrown because he cannot cling with his legs, the adductors are weak and we encourage strengthening of the muscles by their innervation.

Convergence is defective because it is not exercised, but he does not think this form of convergence is of central origin, for this term is generally understood to imply a material cerebral lesion.

Still another form of insufficiencies is where the muscles are really weak, in which the field of fixation shows a limitation on the nasal

side. It is the muscular insufficiency, which gives rise to asthenopia with or without binocular vision. The existence of muscular insufficiency has been denied, as if the ocular muscles could not become incompetent in their work, just as in the cases of other muscles. Thorough examination would dispel such theories and prevent such statements—notably the field of fixation.

There are cases where the convergence is rudimentary and the muscles are weak, as in myopes, where the excursion laterally is limited to a very few degrees and has no duration. This is accounted secondary. There is also a primary insufficiency due to congenital defects. Such conditions are met with in other muscles, why not the eye?

DIAGNOSIS OF CONVERGENCE.

“To know one’s power of convergence, determine the distance of the nearest point to which one can converge,” and compare with value found in the same way in healthy persons.

The Ophthalmo dynamometer consists of a cylinder blackened outside, and in which a candle forms the light. There are slits and circular holes, covered with ground glass, furnishing luminous apertures. To measure, a tape line is attached, which is rolled up by a spring. The tape is graduated in centimeters and meter angles. To determine the maximum of convergence, use the luminous slit, one third of a millimeter in breadth for fixation, placing it in the median line. It is then drawn up until there is diplopia (crossed). This is the *near point of convergence*. One eye, with a red glass, will sometimes enable the patient to perceive the second image. To measure accommodation, there are the fine openings to let the light through small punctures.

With a maximum of 9 M. a. to 10 M. a., Landolt says, “that he has rarely met insufficiency of this function, among persons capable of converging to a point 10 centimeters distant. Since two thirds of the convergence must be kept in reserve, 9 M. a. would suffice for a distance of 33 centimeters. 25 centimeters 4 M. a. would demand 8 M. a., hence 12 M. a. altogether. This is not rare but less for this point, he would soon tire. If, in case of only 8 M. a. the work must be removed further away, or a frequent interval of rest is necessary, or asthenopia follows after a mixing up of the objects. The parties often have a distinct sensation that one of the eyes has deviated outward. With some, the phenomena

of insufficiency, is a difficulty in directing the gaze from one point to another where distances vary. These successful fixations are not executed with the facility of healthy eyes. Objects before being fixed are double or indistinct, and in the movement of the eyes there is a feeling of annoyance. A closing of the eyes, or a gaze into the distance rests the muscles but the fatigue becomes more intense and necessitates repose. Asthenopia increases to such a degree as to render all work impossible, or a production of cephalalgia, hemicrania nausea, vertigo, etc. A short objective examination shows the behavior of the eyes; when directed to a near point, there is a recoil, a withdrawing from the object, oscillation and at last a divergence. The phenomena will manifest itself in only one of the eyes, one fixing and the other turning outward. This behavior will be similar in all eyes as we approach their maximum of convergence, but the pathological conditions will be seen earlier in some; according as the deficiency is developed. The maximum of some cases is on the negative side of zero, and at a distance, and the amount is measured by abducting prisms. We are to measure the excursion of the eyes by the perimeter. The state of the mobility will then be completed by the determination of the equilibrium. The point of absolute pose, which he proceeds to find on the distance, is more difficult. The examination must be objective. The eyes are so mobile, the inner value of the motor apparatus is both so complex and so delicate, that even a semi-conscious thought suffices to modify their relative direction. Only narcosis or death brings about an absolute relaxation of the ocular muscles.

To withdraw the patient from influences that would give direction of the eyes. 1st. At a distance accommodation is not required. 2nd. Making the images dissimilar by means of a colored glass over one eye, the tendency to fusion is less. 3d. With prisms by which insurmountable diplopia is produced there is even less tendency. Some are led into the dark and then required to open their closed eyes and say, at the moment of opening, whether the luminous object is single or double, or they take position in an absolutely dark room, with their eyes open and a light flashed at a distance. The Maddox rod that is mentioned is good.

Landolt has most confidence in Von Graefe's method of placing before one eye a vertical prism. He does not advocate its application for short distances, in which Von Graefe used it. Abduction, at a distance, is the negative of the amplitude of convergence, and he says, "to the same extent that investigation of absolute divergence

is rational and useful, so is the opposite attempt (by means of abducting prisms) devoid of sense, utility and accuracy." He regards the exercise of abduction and adduction," without changing the accommodation.....places the patient in conditions of vision which are entirely abnormal." These investigations of the equilibrium and latent deviations of the eyes, in no wise inform us, either of the amplitude of the eyes for work or of the nature of the asthenopia." He gets but little in the study of equilibrium. Where there is divergence there may be no insufficiency of convergence. The tendency to diverge or converge gives us the position the eyes would take if binocular vision was lost.

He has devised the Kinothalmoscope, an adjustment made of a plate of glass with handle on which he places objects, as reading, upon which the eyes are fixed, and the observer, looking through the interstices of objects, can observe the behavior of the eyes in doing so.

TREATMENT OF INSUFFICIENCY OF CONVERGENT AND OF DIVERGENT STRABISMUS.

These are so intimately related to each other, that the treatment of both may be combined under one head. The constitutional etiology is made prominent, physical, moral, and intellectual; out of door exercise, hydrotherapy, change of environment, travel, etc. The exercise of the impotent function, more than anything else will render them service." He takes up the controversy on the exercise of the muscles, wherein there are directly opposite opinions. Noyes recommended exercise, but Von Graefe advised the opposite. Exercise would only fatigue and weaken them still more, but Landolt sees that both may be right in different conditions. When the infirmity is ascribed to a lack of exercise, and after surgical intervention, the exercise is recommended on the near objects. In cases of commencing divergence, when binocular vision exists, but where one is amblyopic or amaurotic these are excluded. Where binocular vision is lacking, but sight of both eyes is fairly good the treatment should begin by stereoscopic exercise. In most instances, orthoptic treatment should be preceded by tenotomy. All these treatments, general or orthoptic, even under the most favorable circumstances, demand much time, hence it has been sought to solace the victim of asthenopia or insufficiency of convergence by means of palliatives, until the infirmity shall have disappeared. In short, it has been sought to diminish the convergence required for the work." Thus, he proposes, first

to remove the object to a greater distance or necessity of holding close by placing a concave glass, which would stimulate convergence, or put prisms on to take the place of convergence.

The decentering of the lenses, that are necessary to be worn, convex or concave, is spoken of. He says, "great hopes are entertained as to the efficacy of prisms in the treatment of motor asthenopia." These hopes have not been entirely realized.

The following work is another of the translations of D. B. St. John Roosa, M. D., L. L. D., Professor of Diseases of the Eye and Ear, in the New York Post Graduate Medical School, and Surgeon to the Manhattan Eye and Ear Hospital.

1889.

DR. HERMAN SCHMIDT-RUMPLER.

Professor of Ophthalmology and Director of the Ophthalmological Clinic, in Marburg.

OPHTHALMOLOGY AND OPHTHALMOSCOPE,

Translated and Edited by

D. B. ST. JOHN ROOSA, M. D., L. L. D.

ASTHENOPIA.—Dr. Herman Schmidt-Rumpler, under the head of “Insufficiency of the Internal Recti,” defines Asthenopia to be, “want of endurance in close work.” For example, when the patient reads, the letters become indistinct after a time and are even seen double. In addition, there is pressure in and above the eyes; headache and nausea may also be observed. These symptoms depend upon the insufficient activity of the internal recti, which soon grow tired. At first both eyes are accurately adjusted in reading; after a while the power of the interni relaxes, and the eyes assume a position of divergence. At the same time crossed double images appear, of which, the patient usually is not fully conscious; they produce, merely, the phenomena of “swimming” or “blurring.” If he again attempts to adjust properly, by a new impulse of convergence, the letters again become indistinct. The repeated relaxation and tension of the muscles is a source of the complicating nervous phenomena.”

Under Asthenopia Nervosa, (Retinal Asthenopia) complaints of deficient endurance in working, with darkening and swimming of the objects looked at, occur in cases in which, after exclusion of errors of refraction and accommodation, insufficiency of the interni, etc., we can assume only nervous causes. In these cases, there

are usually pains in the eyes and head, which continue, even after the work is abandoned. There is often great sensitiveness to light. The affection is due, partly to general nervousness, and partly to a local hyperaesthesia of the retina.

Dr. Rempler quotes Dr. Noyes, where he states that, "insufficiency of the internal recti" may also give rise to asthenopia. He gives the equilibrium, "that is made for a distance, which corresponds to the individual reading distance." Asthenopia, "weak sight," is found in hypermetropia. The translator explains, "that the author, evidently, takes the view of the relations of asthenopia to general disease, taken by the vast majority of oculists throughout the world, that is, that while certain forms of headaches, neuralgias, quite frequently depend upon ocular defects, there is no large class of constitutional diseases such as chorea, epilepsy, or even migraine in any large proportion, that may be cured by the use of glasses." The balance or equilibrium is not discussed, and there is no handling of divergent squint. (Under hyperopia.) "If asthenopic symptoms develop, convex lenses must always be resorted to.

TREATMENT.—Should be chiefly directed to the cure of the constitutional anomalies, on account of the obstinacy, which is often manifested by the disease; complete cessation of work and a trip to the country or the mountains are sometimes necessary. Operations on the muscles consist in Strabotomy of either the internal or external recti. He had no success in the "stereoscopic exercises."

There has not been a more active or industrious man in the sphere of medicine in this country, or one who has done more for the advancement of his profession than the late Dr. Roosa of New York.

He has written more in his particular branches of medicine, including his translations of German works, in the specialties of Eye and Ear", than any other man of his time. He was active in the organization of Schools, Hospitals, and Societies—especially in Diseases of the Ear, he was considered in the front rank of his profession.

1894.

D. B. ST. JOHN ROOSA, M. D., L. L. D.

Professor of Diseases of the Eye and Ear in the New York Post Graduate Medical School and Hospital; Surgeon to the Manhattan Eye and Ear Hospital; formerly Professor of Diseases of the Eye in the University of the City of New York, and in the University of Vermont.

**A CLINICAL MANUAL
OF
DISEASES OF THE EYE.**

ASTHENOPIA.—Since we have such high authority for considering a hypermetropic formation of the eyeball, as being at the foundation of most cases of true asthenopia, I fully adopt the opinion, including hyperopia and astigmatism.

Asthenopia may be divided into true or local, and the false or symptomatic. I regard true asthenopia as that which depends upon a refractive anomaly, and I consider that, as symptomatic or false, which depends upon some error in the general nutrition, neurotic constitution, nervous exhaustion and the like. These have been very much confounded in the discussions, which have obtained in this country on this subject. There has been a great deal written, avowedly not on the basis of Donders' investigations,

but claiming to involve new ideas on this subject, which seems to me, in many instances, to be but a going back to the erroneous doctrines, which Donders undertook to combat. Asthenopia means an inability to continue to use the eyes on near objects, without involving painful consequences. Some of those consequences are at once appreciable, and cause the patient to stop his occupation, indeed, compel him to do so." Here he adds to the list of other writers, "inflammation of the edge of the lids, peculiar headaches." Certain constitutional conditions that involve accommodative fatigue of the ciliary muscles, may produce symptoms simulating true asthenopia, but these should be carefully distinguished from those resulting from errors of refraction. Epilepsy, chorea, etc., have been thought to result from these conditions. With that doctrine, I have no sympathy. Latent errors of refraction have very little to do, as a rule, in my opinion, even in the causation of asthenopia, and nothing whatever in the production of constitutional disease.

MUSCULAR ASTHENOFIA.—Although I formerly accepted the ordinary classification of an asthenopia, dependent upon insufficiencies of the external ocular muscles, I have finally come to reject it altogether. Of course, I do not deny the existence of insufficiencies of the interni, chiefly in myopia, and the externi, principally in hypermetropia, nor do I deny that there are many eyes, whose external muscles are not capable of doing the average degree of work, but I hold that all these conditions depend on static fixed conditions of the eyeball; that they are direct consequences of these conditions and should not be denied a special nomenclature, but should be classed under the head of asthenopia occurring in Myopia, Hypermetropia, Hypermetropic Astigmatism, etc., from faulty conformation of the eye. I formerly measured the relative power of muscles; this relative power varies in different individuals, who have no trouble with their eyes, and I, therefore, no longer measure it. Physiologically, it may be interesting, but it can do nothing toward the proper treatment. Then Myopia, being rarely asthenopic, its congestion or inflammation, which is thought to be asthenopia, is not true asthenopia; neurotic invalids, suffering from neurasthenia, often have great difficulty in using their eyes, but they also have difficulty in performing many other functions of the body. No adaptation of glasses will materially assist such persons, except by what may be termed suggestion.

Roosa says, "that Donders mentioning muscular asthenopia in his book was "owing to his reverence for the opinions of Graefe."

and further on he says, "I believe that if we set aside sentiment as to Graefe's discoveries and preconceptions, and examine asthenopia in the light of Donders' work upon hypermetropia and that of Javal upon astigmatism, we shall have no occasion to look to insufficiencies as faults needing correction, except when they cause deformity or destroy binocular vision, when, if possible, they are to be removed by operations. The sources of true asthenopia and its results are, in my judgment, to be found in Ametropia.

TREATMENT.—His treatment is by attention to ametropia only. He remarks that, in his opinion, the very best that can be done for them is to make rather light of their troubles, and correct their astigmatism. This accomplishes more than any other system of treatment, and if the practitioner is firm with them and informs them that this is the best that can be done, they go on with their work and do it with very little inconvenience. The examinations are not extended to the inquiry of balance or equilibrium, but the thought is that the equilibrium or imbalance has no significance. He has abandoned tenotomy and use of prisms for the correction of muscular anomalies, and believes, "that the nomenclature to describe weakness of the muscles should disappear." He has found astigmatism to be the cause and its correction the cure. "The Asthenopia with us in the U. S. is directly traceable to the weakened constitutional conditions."

The voluminous and Encyclopedic method of compiling "System of Diseases of the Eye," and its extensive introduction into the libraries of the Oculists of this country, gives weight and authority to any part of the subject of Ophthalmology. As this division of the work is handled by one of the editors of this system, it draws a closer attention to the views taken by its writer than if apportioned to another. We therefore give it much space.

1900.

CHARLES A. OLIVER, A. M., M. D.

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**AMETROPIA: ITS ETIOLOGY, COURSE AND TREATMENT
SYSTEM OF DISEASES OF THE EYE. VOL. IV.**

That the eye of the savage differed from that of the civilized man is made manifest, when the modes of livelihood are contrasted.

The savage gazed for brief periods of time, at near things, and educated his visual power for distant objects both day and night.

The civilized man engaged in in-door pursuits; his visual organs had to be adapted to near work.

The wear and tear, in this latter type, is greater and is so often abused that there is structural impairment.

These are the physical penalties of increased mental force, and the consequence is, that man must accept the conditions, so that he may enjoy the fruits of civilization and culture.

The overtaxed visual function is manifest among the professions, the artisans, seamstresses, weavers, and even the house-wife. The newborn may be given an inheritance unstable, and not able to withstand any ordinary amount of use. It signifies a transmitted fault, expressing itself through physical or physiological impairment.

Examinations show, that the ordinary shape of the unemployed eye of the human species, presents a short diameter to the entering rays of light. Similar peculiarities of structure exist in the eye, such as differences in cephalic configuration and facial contour.

The "normal eye" is not one with the findings mathematically correct or that of the emmetropic standard, but that in which the perfect visual result is obtained. It is doubtful whether the ideal one exists. The emmetropic eye is the transitional stage between hypermetropia and myopia. It is one which focuses distant parallel rays on its foveal plane without muscular effort, giving distinct images of distant objects. "It is a refractive halt in an asthenopic eye." Practically, it should always be sought for. "The condition artificially obtained, is however, not always the best for the well being of the organ."

"There are two end organs, each of which receives a sensory impression, which it is necessary to combine into a single perception-binocular single vision."

"Though ametropia is as wide spread as the world itself, yet asthenopia is the bane of the civilized minority." It is dependent on many interrelated and interdependent conditions," for example, ametropia and asthenopia make their appearance or heterophoric asthenopia is provoked. The first is that which includes in its etiology both the sensory and motor disturbances, that have their origin in badly shaped eyeballs. The second has for its cause ideopathic or functional errors in muscle equilibrium, that may be independent of the shape of the eyeball and the condition of the refraction."

"Heterophoric Asthenopia is not so rare as may be supposed, be the ametropia ever so slight or undisturbing, or even if emmetropia be found, asthenopic symptoms of heterophoric type may be present. Moreover, ideopathic or primary heterophoria, particularly hyperphoria, may not only produce a heterophoric asthenopia, but may also provoke an ametropic one from a latent ametropia, which would not have been brought into evidence had there not been a normal equilibrium and action of the ocular muscles"

ASTHENOPIA.—"Considered broadly, Asthenopia or eye-strain is a complex grouping; as a rule, it is expressive of the combined workings of the two ocular end bulbs and their accessories." "What may be considered the normal state of the visual apparatus today need not be that of tomorrow. "Normality can be assumed, no matter what inequality may exist, as long as the two series of ocular muscular groupings are in balance and continue so during activity."

"It is the heterophoric type of asthenopia, particularly the hyperphoric variety of minor degree, more than it is the ametropic one, which gives rise to so many reflex neuroses. It is this type of disorder that dizziness, gastric disturbances, with, for example, urticaria, vertigo, migraine, nervous irritability, mental confusion, insomnia, etc., all of which are so prone to interfere with general nutrition, come into existence."

"In this category are to be found the many changes of vaso-motor type. In this group are to be seen the characteristics of the vicious circle of cause and effect; eye strain, with its pain and nervous disturbances, producing interference with assimilation and nutrition, which, in its turn, so reduces the general physical condition as to induce an increase of the asthenopia."

NERVE STORMS.—"The nerve storms that are produced by heterophoria (as also ametropia) may produce a rapid discontinuance of near work, so that the more distant reflexes may never be given an opportunity to manifest themselves. There may be so strong nerve tone that the excitation may never make an impression—just as ametropic and heterophoric asthenopia may produce far reaching and injurious symptoms that cannot be removed in any other way than by correction of the local defects"—so must general disturbances be remediable by therapy, "directed to the casual factors."

In the neurotic, toxæmic and anaemic, small errors sooner manifest their presence. Some of the functional nervous diseases and some of the morbid processes, named neurasthenia, chorea, epilepsy "may be indirectly dependent upon disturbed binocular action."

NEURASTHENIA.—Neurasthenia produces Asthenopia; Functional Paresis of the motor apparatus; irregularity of pupils; lachrymation; congestion; sensation of foreign material in the conjunctival sac from want of tone and localized dilation of the vascular walls, with a sense of weight and a tendency to drooping of the upper eyelids, hyperaesthesias, and irregular spasmodic actions.

HETEROPHORIA.—"It is the minor and unequal degrees of heterophoria (particularly hyperphoria) that produce the most disturbing reflex symptoms. This is especially so, if there be some peculiarity of angle of muscle-deviation or faulty muscular tendency."

"Neuralgia, the functional expression of a disturbed nerve, is one of the most common signs of ametropia."

"In the trifacial and second cervical groupings, on use of eyes, it manifests itself, especially when the system is below par. Low

grade of compound hypermetropic astigmatism, mixed astigmatism, etc., produce the greatest amount of headache; anisometropia, and antimetropia, increase the frequency of cephalalgia.

DIFFERENTIAL DIAGNOSIS.—"As yet, the differential diagnosis between the cephalalgia of ametropia, and that of heterophoria is uncertain, though it is probable that when the pains are associated with dizziness, and ear "sickness," that abnormal balance is the more to blame. As a rule, however, the two conditions are associated and interdependent."

LOCAL REFLEX EYE STRAIN.—Asthenopia may be produced by conjunctival and pulpebral irritation and inflammation, associated with pterygia, chalazia and abnormal adhesions of lids. Whether naso-pharyngeal disturbances can be included in this category is uncertain, although the removal of adenoids has directly relieved cases in which the correction of the ametropia and the heterophoria has availed little or nothing. Nasal reflexes and dental caries must also be considered. Many subjects, suffering from frontal neuralgia and complaining of eyestrain on rising in the morning, may be dependent upon congestion of nasal cavities, conjunctival irritation, that has been provoked the evening before by improper use of the eyes.

SPASTIC.—"In the spastic or overacting types of heterophoric asthenopia, particularly, when there is hyperphoria and the interior muscles are also affected, migrainous attacks are common." "In the forced or over acting exophoria, the more general signs, such as vertigo, incoordination, mental peculiarities, and even insomnia, and neurasthenia are noticeable."

"Undue action of the interior muscles (sphincter irides and the ciliary) being supplied by the third nerve affects all the related exterior muscles and produces a departure of the globe from orthophoric equilibrium."

PARETIC.—The paretic or underacting form of heterophoric asthenopia, found so frequently in the aesthenic is dependent on weakness of the muscles of the third nerve. The symptoms vary in all forms of cephalalgia from mere frontal to fronto-occipital pain; the greatest disturbance always being found in the positions of the weakest groupings or combinations of muscles. In a mixed type (underacting and paretic) where the extrinsic and intrinsic muscles are weak from general debility, there is a subnormal ciliary action, associated with dilated pupils and exophoria, during near vision in which there is both ametropia and heterophoric disturb-

ance, with an inability for prolonged focusing, imperfect fixation, visual confusion, dizziness, and gastric disorders. Not only the muscles supplied by the oculo-motor, but those of the fourth and sixth become lowered in action.

CLIMATE.—Climate as an etiological factor, as a cause of asthenopia, is discussed, in that, in one section, there is more strenuousness required to obtain the necessities of life than in the other, where nature supplies the fruits to appease the appetites with less labor.

LIFE STRUGGLE.—Then, added to the struggle of life for subsistence, the procuring of the necessities, and those living in the more rugged climates, set standards of skill, education and proficiency, all of which “cause wear and tear of the structural organs,” and in the case of the eye“” are, unremittingly, and often injuriously brought into play”—hence it is not possible to consider the functions of the visual organs as dominated by any mathematical laws, but the adoption of anatomic elements subserve the purpose for which they were intended.

MUSCLE EQUILIBRIUM.—Among the etiological causes of heterophoric disturbances, the great majority of faulty muscle equilibrium is the result of a transmitted over stimulation, given to the ciliary muscle, the consequence of ametropia; it is an associated error, the effect of individual imperfection. “In the vast majority of cases, muscle disturbance is the result of unlike degrees of minor amounts of ametropia in two organs that are found to work as one organ.” Comfortable vision may be with heterophoria, both manifest and latent. It may be the result of a spastic condition of one muscle and a paretic condition of another.

ASTIGMATISM.—As one of the causes of astigmatism is the tonic contraction of the exterior ocular muscle groupings, a spastic condition of a series of extra ocular muscles, as is occasionally seen in some types of nerve disease. Both surfaces of the cornea and of the lens, as well as the density of the different portions of the two masses, must be taken into consideration.

The astigmatism, determined in examination of each eye separately, is often different in amount; when the examination is made with the eyes simultaneously, the angles of the meridians likewise change. This is possibly accounted for by the extra ocular muscles, producing different degrees of tension in their combined functioning.

HETEROPHORIA.—Muscle equilibrium is pronounced in cases of one or even two degrees of deviation, (exophoria in myopes and

esophoria in hypertropes) for five or six meters distant and slight exophoria at reading distance. It is seen in cases in which the astigmatic axes are at 90 degrees. The deviation in the vertical direction is much more troublesome.

"HETEROPHORIAS soon become apparent with the minor degree of ametropia, particularly of the astigmatic variety. Latent exophorias are often made manifest by the use of prisms and the repeated performance of the so called graduated tenotomies."

"HYPERAESOPHORIAS are quite common in young, highly hypermetropic and astigmatic subjects, while hyperexophorias, with slightly dilated pupils, are the rule in the middle and the high grade myopes. The extra ocular muscle imbalances are the greatest in antimetropic and anisometropic subjects."

Like ametropia, heterophoria is divisible into manifest, latent and total.

The local symptoms of external deviations are frequently those that have been shown to be dependent on underaction and paresis.

"An odd symptom is the sensation of a sudden impact against the eye ball, produced, probably, by a simultaneous action of two or more of the recti muscles;" ptosis may be caused by hypermetropic disturbances, tilting of the head away from the shoulder corresponding with the hyperphoric eye; palpebral hyperemia with watering of the eye; diminished vision, and comprising double vision as seen in car sickness, with all manner of general reflexes that are more or less distantly related, constitute some of the other signs of heterophoria.

CYCLOPHORIA is an imbalance of equilibrium and action of the exterior ocular muscles. It is most frequently seen in oblique astigmatism and is mainly connected with the oblique muscles.

Facial wrinkles, corrugations and even grimaces are symptomatic of heterophoria.

A variety of general symptoms are not noted until the ametropia or heterophoria are corrected, thereby getting rid of an expenditure of nervous energy, which would have, if continued, been an injurious influence upon the general health.

It must not be forgotten that general organic lesions, particularly those of neural structures, may give rise to similar signs.

PROGNOSIS.—With proper care and rest, work can be secured from the visual organs. "Mischief manifests itself when friction begins, and if not recognized and corrected, is apt to produce

physical disorders." Ametropia has no major place in the statistics of blindness, but it slowly extends its harmful impulses, which frequently are but imperfectly recognized, and so imperfectly corrected that its evil consequences become more widely spread."

In the sedentary lives of asthenopes, "the weakened sight is but one of the evidences of general nerve tire."

In a country where myopia was increasing, attention was called to asthenopia two decades ago, and America profited by the object lesson, and reform has been the result, through her optical establishments as in other hygienic measures. Notwithstanding the "want of harmonious binocular action," until the last decade and a half, it has generally remained untreated.

Owing to the general strenuousness of our people, where so much nerve energy is wasted, we find asthenopia at its worst.

"Such a complex organ, so situated, as its work continues, must cause harmful influences on distant related organs."

The private schools, whose pupils are from the well to do classes, with less rugged constitutions, afford illustrations of the causes and effects of asthenopia; physical unfitness, and inadequate strength for the performance of their real life work, especially among brain workers are some of the results; neurasthenia becomes manifest and the eyes are among the earliest organs to become involved.

The effects of impaired vision on the intellectual development and physical growth of the subject are marvelous, often unrecognized until too late, when the disturbance becomes increasingly harmful.

Theoretically, the emmetropic have the fewest injurious influences; practically, there cannot be any ocular ideal, and an emmetropic eye cannot be expected to remain so, when its dioptric media is so changeable, and its muscular movements so indeterminate.

Lens Therapy should be subject to legal regulation.

Municipal statutes should be enacted for the examination of pupils.

Correction of ametropia, particularly astigmatism, has lessened myopia; disastrous intraocular changes, associated with myopia, are not so frequently seen at the present.

Myopia is a direct accompaniment of advanced civilization, but cannot be attributed to embryologic causes. Mental pursuits require prolonged near vision from early life, and therefore the best sight attainable. Uncomplicated Myopia is rare and the lower grades of the schools present but little asthenopia.

Minor degrees of ametropia and heterophoria produce impairment of nerve energy, by abnormal expenditure of nerve force;

early correction leaves fewer chances of nervous impairment or organic disturbance.

TREATMENT.—“A normal eye is one that has healthy tissues and is functioning properly.” “It need not be emmetropic nor neither need it be exactly like its fellow. By over use, however, pain is produced and rest, orthopedy by lenses and prisms must be applied. While improvement in vision is brought about, ocular disease is the main condition to be improved. The uncomfortable vision before inflammation and acute ocular pain are the principal symptoms that send the ametropes for relief,” and the almost universal belief that all defective vision can be relieved by lenses acts disastrously on the welfare of the organ.”

The science of prescribing for ametropia is not a mechanical art. It is the work of the educated, who understand the significance of the eye's strain on the general health. The end organ is improperly compared to a camera—it is a living mechanism. The employment of a correcting lens is medical therapy. Like other therapeutic aid, its virtues have been exaggerated.

Eighty per cent of Ophthalmic work is for the correction of ametropia. Unlike our ancestors, people of the present day need not be doomed to pursue lives of uselessness, out of doors; on the contrary, scientific medicine would be criminally negligent to give such advice,

We cannot expect to cure “static” ametropia without surgical procedure, but “dynamic” can be cured, both by local and general methods. The orthopedic therapy is a lens and acts as a crutch, and it cannot be expected to remain efficient without changing.

Lenses should not be used, merely to benefit vision, but to prevent disturbing causes and disordered mechanism. It is not the amount of ametropia, which determines their necessity. A cylindrical lens of 12. D. has frequently done more good as a therapeutic measure, in changing muscle imbalance than general treatment, or so called “rest lenses.”

“All refractive errors, especially minor degrees of astigmatism, should be carefully estimated for, at least as low strength as one eighth of a diopter.”

The total error, particularly the astigmatic one, must be found, before the proper orthopedic help to the combined organs can be established. In all subjects under 45 years there must be full paralysis of ciliary muscles.

Select a cycloplegic that is deemed best adapted to the particular case and get full effect of control of accommodation.

"To relieve asthenopia, it is just as important to obtain definite data of heterophoric changes;" artificial control of the extra ocular muscles; we do not have to determine the amount of heterophoric action, particularly the latent in any definite position," though clinically, the muscle equilibrium, for distance, may often be advantageously tried, while the ciliary muscle is artificially paralyzed."

Prismatic corrections have their limitations. "During their use, there should be definite modifications of power for every finite point used. Unfortunately, in such corrections, there are the most troublesome factors of identical points, that are situated throughout the associated fields of vision."

No therapy of any kind should be applied to the extra ocular muscle until the ametropia is relatively corrected; the powers of the combined muscle action, in the four principal directions, must be learned and the inter-relationship of the two ciliary muscles must be studied. "It is a series of motor impulses in unstable muscular apparatus of dual type, independent of set mathematical rules and fixed certainties."

Optometry, the science of measuring the optical powers of the eye, in practice, divides itself into objective and subjective; 1st. Ophthalmoscopy-Keratometry and the Fundus Reflex test are employed. 2nd. Test Lenses. For determining related muscle imbalance, both objective and subjective tests should be applied both for distance and working point, and also for other focusing.

"The methods of testing heterophoria, are as a rule, very imperfect." The muscular condition should be gotten repeatedly, in order to gain averages of muscle balance. "The duction powers of muscle combinations that produce the various combined ocular movements, must always be tested."

Prescribing lenses brings into consideration a whole series of dynamic forces, situated in and around two closely related eyeballs. It is one of the most difficult problems, given a physician, and is one of the most important therapeutic agents that has been offered to the profession.

No case of binocular ametropia has been properly treated until the disturbances of both the related extra ocular and intra ocular muscle groupings (which are brought into almost momentary play) are gotten rid of as nearly as possible.

"The production of an artificial ametropia is not infrequently necessary, in order to obtain a pair of comfortably working and non-irritating visual organs."

The secret is to bring about as close a proper relation between the two conditions (extra and intra ocular premises) in each in-

dividual case as possible, hoping only to approach the ideal state. "As a rule, a total correction of binocular ametropia (particularly the minor types) not only removes a false tendency of the globes, in some definite direction," but "restores the extra ocular and the intra-ocular series of muscles to a normal inter-relational balance, thus permitting proper equipoise, without undue or harmful innervation impulses to take place, when moved into associated positions."

"In the majority of cases, the question is to get the two eyes to work together harmoniously, for the generally employed, distant or near working points; to reduce the optical and the muscular strains to a minimum, in agreement with what it is expected of the organs to perform." "Normality and emmetropia need not be the same; it may not be the best practical basis."

In heterophoria, when amblyopia is threatened, correction of ametropia, stereoscopic exercises, periodic use of the organs should be carefully attended to. If vision remains below normal, radical procedures may be resorted to. Each form of therapy has its limitations and operation as an ultimatum.

"Orthopedic treatment of ametropia should really be frequently considered as to removal of the etiological factors in asthenopic symptoms." "Prisms combined with sphericals instead of cylinders signify uncorrected muscle balance, which might be remedied by sphero-cylinder."

Ideopathic, that is anatomic, is the only type of heterophoria that legitimately permits operation, and this is the only remedy. "It must be "structural" or "insertional" in character."

"For removal of reflex disturbances, reflex irritants or the offending relationship must be sought."

In functional forms, after correction of ametropia, there should be hygienic attention to general nerve tone. "Rythmic exercises, not carried to excess, and in some instances innervation impulse tests are of use.

"These two types of heterophoria are distinctly separated," and the two procedures can be accomplished only by the scientific medical man.

"If the external groupings are suffering from the secondary exhaustion, much good can be done by obtaining and retaining a normal working balance between the two related series." Never in heterophoric or heterotropic errors should attempts be made to weaken any set or sets of muscles. Find the weak and strengthen them by orthopedic measures.

The paretic type is evidently dependent on general systematic disturbance. Hygiene and internal medicine are indicated. Forms of strychnia, hypodermatically administered. Local therapy is useless without general treatment.

In the neurasthenic types, frequently seen among the intellectual, optical and musculo-dynamic correction are of but little value.

Prolonged and absolute change, rest and properly taken exercise, both physical and mental, can alone effect a cure.

A partial correction of astigmatism, or even omission of the astigmatism found in cycloplegia, and in others, a frequent change of axes may be of value.

For slight esophoria, for distance, prisms are not best. In low degrees of exophoria for near vision, base in, prisms can be put before the helping eye. If later, muscle equilibrium be again disturbed, as it frequently is, "hygiene of eye employment, temporary cessation of work, spherical and prismatic correction and general constitutional remedies are employed.

Theoretically, "the cure of asthenopia is the artificial production of emmetropia and orthophoria, yet practically, such ideals are rarely preserved," "nothing more can be expected in the removal of asthenopic conditions than to approach as near to a refraction and muscular ideal as possible."

Some cases of "spasm of accommodation" are so persistent as to require months of active treatment.

"Migraine is one of the main causes of ocular disturbance." Clinically, get the eyes into a normal state, and hygienically treat generally associated neurotic conditions, which are probably one of the principal casual factors in the production of the affliction."

Habit Chorea of refractive origin, has a tendency to invade other muscular groupings besides those of the eye-lids and face, and is bettered by correction of ametropia and heterophoria.

Headache. It would be well to estimate the refraction in all cases of functional neurosis, situated around the eyes.

Presbyopia. The ametropia of each eye must be considered. This done, the artificial combined points for near work can readily be obtained. Properly centering should have the same care.

"In the placing of prisms in lenticular corrections, it is best to put the bulk of the prismatic action before the helping eye, which is generally the left one."

The contribution to the science of Ophthalmology by Dr. Stevens, in instruments of precision in Diagnosis and his new nomenclature in Muscular Anomalies, and the new views in which he presented the relation of the extra-ocular muscles to the subject of Functional Vision, together with his method of relief of asthenopia by "gradual tenotomy" marks an epoch in the history of Ophthalmology.

1906.

GEORGE T. STEVENS, M. D., Ph. D.

A TREATISE ON THE MOTOR APPARATUS OF THE EYES.

MOTOR APPARATUS OF THE EYE.

This work follows his book of "Functional Nervous Diseases," published in 1884. The central doctrine in this, he states in the preface, is difficulty of adjustment of eyes, which is a source of nervous trouble, and more frequently than other conditions, constitutes a neuropathic tendency.

He gives an interesting history of how the ancients regarded deviation of the eyes, and states that the opinions expressed as to cause, were copied by subsequent writers and thus handed down nearly to our own day.

In the history of muscular anomalies that are less than strabismus, he discusses Von Graefe's Insufficiency of the interni and the sacrifice he made of single vision, for a distance, for convergence, for reading distance; by an operation he made that condition, declaring that his doctrine of obtaining fusion at one point at the expense of another point, would not be tolerated in these days.

He holds that in the introduction of his system of heterophoria, he gave expression to new facts by new terms. In a series of cases, reported to the Royal Academy of Medicine in Belgium, 1883, for which he received the award in a competition. His proposition was; that "difficulties of the adjustment of the eyes are a source of nervous trouble, and more frequently than other conditions, constitute a nervous tendency."

The difference between Von Graefe's practice on adjustment of the eyes, and his, was that the former did not establish equilibrium for all points, but he sought that result. In seeking this, the practice of tenotomy under it became more refined and more scientific. He regards his instrument, the Tropometer, in these cases, as shedding a flood of light on the subject, and, for a time, it seemed as though a key had been found to unlock secrets. The anomalous position of the plane of vision was first shown by it. With all the investigations of Helmholtz, he shows that the true investigations of the subject of the muscular apparatus had not yet been made. His instruments for technical physiological investigation enabled him to make a class of examinations better than all that had gone before.

The maintaining of the uprightness of objects seen by the eye, is one of the important impulses. The construction of the muscles, which roll the eye upon its optic axis, is an element of cause in exophoria; that when the rotation of the eyes, in its full extent, is understood, it will no longer be necessary to perform tenotomy for convergence or divergence squint. The full understanding of heterophoria and its bearing on the nervous system fairly constitute a science.

He sees that oculists will, in the future, hold a closer relation to the physical well being of patients in correcting bodily postures, which go far to produce ailments from pose of the head and eyes.

In the section of Physiology of the eyes, he makes a close study of *torsion*, the wheel like movement on and around the plane of regard, making a distinction between this and *declination*. "The angle of torsion is the angle of displacement of the vertical meridian, when the eye passes from a primary to a secondary position." Displacement to the temporal side is positive; to the median side negative. The rotation of the eye is about a fixed point, practically the center of the eye; the muscles performing it are divided into three pairs; each pair, the axis of which cuts the center of rotation, acting alone. It is also to be remembered that neither eye acts independently, but the two eyes are in definite relations and association with each other. The attachments of the different muscles to the eye ball in front, being varied from a right angle to the axis of action, caused deviations from the normal meridians. The conclusion is that the action of the muscles upon the eyeball cannot be uniform. In the associated movements of the two eyes, there is also often a nonconformity of motion from mal-insertion of the muscles. In the combined action of two muscles or pairs of the two eyes, the vertical lines are thrown out of parallelism.

In the combined action of the two pairs, displacements may be detected.

A turning of the eye upon its own antero-posterior axis by direction of the traction of the superior and inferior recti and the oblique muscles is called torsion. The torsion which tilts the upper end of the vertical meridian to the nasal side is negative and that which tilts the upper end outward is positive. The compensating action of the muscles, when in health, prevents torsion.

With the Clinoscope the vertical lines may be made to rotate 20° with the two eyes. The horizontal lines cannot be rotated to this extent.

ANOMALOUS CONDITIONS OF THE MOTOR MUSCLES OF THE EYES, CONSISTENT WITH THE PHYSIOLOGICAL STATE.

EUTHYPHORIA.—A passive adjustment of the normal plane of vision, such that this visual plane is coincident with the plane of the horizon, or very nearly so.

ANOPHORIA.—A passive adjustment of the normal visual plane, at an angle distinctly above the plane of the horizon.

KATOPHORIA.—A passive adjustment of the visual plane at an angle distinctly below the plane of the horizon.

ANOTROPIA.—An adjustment in which the visual line of either eye deviates upward when the other is in fixation.

KATOTROPIA.—An adjustment in which the visual line of either eye deviates downward when the other is in fixation.

ORTHOPHORIA.—A tending of the visual lines in parallelism.

HETEROPHORIA.—A tending of these lines in some other way.

ESOPHORIA.—A tending of the visual lines inward.

EXOPHORIA.—A tending of the visual lines outward.

HYPERPHORIA.—R. or L.—A tending of the right or the left visual line in a direction above its fellow. *The term does not imply that the line is too high, but that one is higher than the other.*

Tendencies in oblique directions are expressed:

HYPERESOPHORIA.—A tendency of one visual line above the other, with a tendency of the lines inward.

HYPEREXOPHORIA.—A tendency of one visual line above the other, with a tendency of the line outward.

HETEROTROPIA.—R. or L.—A deviation of the visual lines.

Esotropia.—A deviation of the visual line inward.

EXOTROPIA.—A deviation of the visual line outward.

Hypertropia. (R. or L.)—A deviation of one visual line above the other.

HYPERESOTROPIA. A deviation of one visual line inward and above the other.

HYPEREXOTROPIA.—A deviation of one visual line out and above the other.

DECLINATION.—He tests the extent of the rotation of the eyes by his Tropometer and claims that before this instrument there had been no reliable method of arriving at approximate measurements of all the rotations. He gives standards of rotation. On the degree of anomalous condition depends the amount of disturbance of the nervous system. The recognition of declination's will mark the advance in the character of the results. The science of declination cannot well be compared with that of heterophoria as they are intimately associated. When the meridian of the retina deviates from the meridian of external space inwardly or outwardly, that is, when the ball rolls upon its visual axis, it is a declination. When the top of the retinal meridian leans towards the temple it is positive (plus) declination; when toward the nose, negative (minus) declination; sometimes these declinations occur in eyes physiologically correct, and are as various as errors of refraction and as important in tenotomies.

Among the distinctive symptoms named in declinations, are chronic hyperemia with smarting and dryness, caused by pressure of the lids against the ball in the endeavor to resist the tendency to roll; habitual pain in and over the brow, of one or both eyes; arching of the brow. He calls his detecting device, "The Lens Clinoscope."

With Myopia, there is usually a high degree of declination. Declinations give contour to the expression of the face, in arching brows. It is easy, not only to recognize the class of declination but to tell the direction of the leaning of each eye. The habitual pose of the head and indeed that of the body, is in a large measure influenced by peculiarities of adjustment of the eyes.

He dissents from the doctrine of Donders, so generally accepted, that of the association of the two functions, accommodation and convergence that an excess of the action of one should cause an excess in the function of the other. "The affections of the ciliary

muscles are not essential factors of the anomalies of the motor muscles, and need not be considered beyond the reciprocal influences, which may arise from habitual associations." Heterophoria may be regarded in general a resultant of declination. As the accuracy of estimation of distance and form is made by the muscular movements of the eye, bringing into position the different meridians over retinal spaces in their relation to the macula, and that these adjustments are made with inconceivable rapidity and frequency, it is important to know the degree which a pair of eyes has to make up by its want of equilibrium, thereby estimating the nervous force expended in any particular occupation. Heterophoria, in one person might not produce disturbance, but, under different circumstances cause trouble; another person with very little deviation might suffer severely when called upon in duties that demand unusual hours; so that a certain degree of fault in the associated movements will not denote the degree of nervous disturbance, or that when there has been no inconvenience from the use of eyes, that there is a well balanced adjustment.

This would indicate that the time to correct anomalies is before the disturbance occurs and if there is such a condition that entails great expenditure of nervous energy, it should be corrected before a breakdown is brought about.

TESTS.—Among the "*Auxiliary Tests* of the Phorometer," he cites duction. This he calls overcoming difficulties in the fusion of images. The measure of it is the strength of prism, which the eyes can overcome. Von Graefe named abduction and adduction, and sursumduction, right and left, which is overcoming prisms base down over R. E. and is Right sursumduction; the same position over L. E. is Left sursumduction. The same terms apply if prism is reversed before the opposite eye.

The ability in *adduction* with orthophoria is 50° base out. Practice and acquiring a "knack" will give such ability but there is no fixed standard. It is necessary that the prisms be placed equally before the two eyes. Not so in *abduction* with base in, but may be placed over either eye. He placed a standard of 8 in abduction. These collateral tests are less in demand, since the discovery of the Clinoscope, yet are not to be ignored. He regards the vertical diplopia test at the reading distance of no absolute value. He depends much upon the screen and the parallax test of Duane.

Esophoria "is not to be regarded a disease or as a weakness, nor yet a spasm." "It is a physiological state, depending upon

anatomical peculiarities of the course and the insistence of the motor muscles, by which...the balance of tension is normally toward the median plane." In exophoria as in esophoria the habitual visual state is the union of the images of the two eyes. When diplopia occurs the deviating tendency has passed to actual deviation, and then exotropia. Exophoria in accommodation, which is a condition analogous to insufficiency of the interni of Von Graefe—not a condition of true exophoria.

In hyperphoria single vision is assumed although, when a single degree exists, subjects of the affection surrender to it. No heterophoria exerts more disturbing injurious influences, giving rise to fatigue, perplexity and it exaggerates all other tendencies. It has a slight deviation effect on type and its doubling effect causes inordinate muscular tension or a suppression of the images of one of the eyes. Amblyopia is not only common in hyperphoria but it is uncommon to find hyperphoria without amblyopia.

Expression of the face and the bodily pose are sufficient indication, in some forms of anaphoria, to indicate a restricted chest and that the respiratory passages are partly shut in a valve like fashion. Although they may not acquire phthisis, the pains in the back of the neck, in the middle dorsal region, and even in the lumbar region are often the physical protest against tension upon the muscles of these parts

"Weakness" of certain muscles is not the cause of different forms of heterophoria. The most conspicuous cause is in the vertical meridian. Declinations are peculiarities of tendon insertions.

The following is the method given for the manipulation of prisms in effecting direction of the muscles. The simplest and easiest, and indeed the most effective way of making these tests is by help of prisms, taken from the trial case. For abduction, take a prism, for example of 5° from the box, and place it with its base toward the nose, close to one eye of the patient, and ask him to unite the images, if two result. If this can be done, proceed to the next grade or pass over one or two grades and try again. In a very few trials the limit will be reached. On the other hand, if the 5° cannot be overcome, a lesser grade is tried, and, if necessary, other lesser ones until a union of images can be found. The strongest prism that can be overcome is the measure of abduction. If there is actual convergence it may require a prism, base out, to enable the patient to unite the images. Then there is homonymous diplopia of the degree of the weakest prism that will unite the images. Prisms of much less grade are usually required for sursumduction. A prism of one, two or three degrees is usually sufficient. Place

the prism, with the base down, before one eye. If this can be overcome, present a stronger one, until, with no stronger one will the images unite. In most cases, a prism of not more than 3° may be overcome. In myopic cases with high declinations, prisms of 9° or 10° may be overcome. After determining the sursumduction in one direction, in a few minutes the prisms can be placed over the other eye, base down as before, or over the first eye with base reversed.

After thus testing in the different forms of heterophoria, tests are made of the rotation by his Tropometer, then the Clinoscope.

Esophoria, which occurs in the proportion of more than three to one of exophoria, plays an important role as a cause of neurosis. When the strain in adjusting the eyes, in close work, may be expressed in the orbit and localized in the muscles in case of exophoria. The reaction, in case of esophoria, is found after direction on a distant point, as upon attending church, theatre or picture gallery, when the eyes have been directed, during a considerable time, in parallelism. The pain is at the back of the head and upper part of the neck, causing a general malaise and sense of illness.

The amount of deviation is not commensurate with the irritating result.

The suppression of the false image gives relief, afforded at expense and perplexity of another sort. Of a large number of cases, which go from one oculist to another, in hope of relief, and submit to an almost endless change of spectacles with little advantage, a very considerable number have slight grades of esophoria. These moderate cases of esophoria may represent declinations, and it is this to which nervous perplexity is due rather than the esophoria. In a certain proportion of cases, accommodation is feeble, pupil sluggish and dilated. Attention is to be turned to the declination, which may induce the esophoria.

Amblyopia is rather the rule than the exception in hyperphoria. In esophoria at least, it is quite common to have but one third of the visual power in one eye.

Nutrition of the eye is interfered with in heterophoria; the crystalline lens and tunics of the eye are affected. The discovery of causes, which induce perverted nerves, is more practical than volumes of profound ambiguity. Muscular anomalies are etiological factors in many forms of eye diseases; blepharites, conjunctivitis, corneal ulcers. A large class of people, who are suffering from "malaria," "billousness," "nervous prostration," "dyspepsia," "constipation," etc., are simply paying the penalty of uncorrected heterophoria.

The influence of Anaphoria, Kataphoria and declination in diseases of the eyes, as trachoma, and in respiratory diseases is discussed at length. Facial expression, taken on from condition of the eye muscles in heterophoria, and declination occupies considerable space in analyzation.

TREATMENT.

TREATMENT OF DECLINATION. Under certain circumstances, spherical and cylindrical glasses, prismatic lenses will have an influence in correcting declinations; no practical use of them can be made in the treatment of this class of anomalies. Strong convex lenses in neutralizing declination may have temporary effect as in strabismus but not in the relief of the ciliary muscles. Gymnastics are not, in any sense, curative.

SURGICAL TREATMENT OF DECLINATION.—Treatment. 1st. General. All the heterophoric conditions are depending on anatomical peculiarities, and cannot be changed by medical or other treatment, directed to general physical conditions, but temporary benefit may result from treatment of this nature. Often the expense of ocular adjustments is greater than the victim can afford, and the result is, economy of nervous energy—rest. During this suspension the general physical tone may so greatly improve that disturbances to health may be lost sight of for a time. The anomaly is not removed. Tonics, change of air, abundant wholesome food, to establish the general vigor of the nervous organization, constitute the principal means for re-establishment of the nervous organization.

Electricity as a local stimulant, may induce a change of nutrition.

He condemns the coal tar preparations, as chloral, sulphoral, etc.

They are paralyzers of the nuclear region, supplying the nerves of the eye muscles and give temporary relief at the expense of more lasting injury.

As direct agents for the relief of functional disturbances, prisms are used, both as a means for gymnastics and in spectacles. He says he formerly gave much attention to exercise of the muscles and it was the means of relieving many of my earlier reported cases. The method of using prisms in gymnastics is thus described. A patient, looking at the flame of a candle at 20 feet distant, a weak prism is placed, base out, before one eye—as soon as the images unite, an equal prism, with its base out, is placed before the other

eye. As fast as images are united this alternate addition of prisms is continued, until it is no longer convenient to add them, or until the patient fails to unite. Then, if union cannot take place, the prisms are removed and the same process is repeated until more can be accomplished if possible. If the patient is able to unite these weak prisms, the surgeon begins with those of higher grade, adding alternately until the images are no longer united. This also, is repeated several times, and thus adding ability can be raised. A similar method can be used in overcoming by abduction, the prism being placed with its base in. In this case, it is rarely required to add one prism above another before both eyes—a single prism before one eye serving the purpose.

Gymnastics for declination can be done by use of Maddox rod twisted from a horizontal position, but to get at the rotations, the Clinoscope is necessary. The use of low degrees of prisms in spectacles, correcting only a portion of the deviation, was carried on by him to a large extent, at one time, but he found a very few who derived important relief, and a smaller number still who found permanent relief. He found better success in cases of anaphoria and kataphoria, using prisms of equal strength on both sides. Strabismus occurs because one or more of the muscles of the eye is disabled or because there is some mechanical obstruction of the free movement of one or both eyes in certain directions.

We have given much space to the review of Dr. Howe's two volumes on the muscles of the eye. 1st. Because it is a late production. 2nd.—Because the principal characteristic of the work is the thorough analyzation of the subject and classification of its minute subdivision and their presentation. 3rd.—It thoroughly represents the general status of the subject, in our time.

1907.

LUCIEN HOWE, M. A., M. D.

Professor of Ophthalmology, University of Buffalo, etc.

THE MUSCLES OF THE EYE.

2 Volumes.

After considering the anatomy of the eye, he gives the plan of study of the physiology of the organ, and comes to the conclusion that for "comfortable binocular vision, especially at the working distance, a relation within certain limits must be maintained between accommodation and convergence and torsion." The geometry of the globe is considered. Listing's plane the center of motion; the angles, Alpha, Delta and Gamma and their clinical importance. The relation of the visual acuity of the action of the eye. "The position that the globe assumes is determined by the sensibility at the fovea is so much greater, there is an instinctive desire to turn the eye that the central part of the image shall fall just at that point." "The smallest space between the points, which can be perceived, must subtend an angle of about 55 seconds"—a fact on which Test Type is constructed. For testing at this near point, "it is desirable to use types for expression in meters or fractions of a meter. if we are to make this part of Ophthalmology accord with the rest."

"The normal eye is accustomed to suppress those images, which do not fall on the fovea to such an extent that we are unconscious of it." "It is sometimes the images of one eye that predominate,

sometimes those of the other, and so long as we can see in a part of the visual field images of one eye, those of the other eye are completely suppressed." *Tscherning*.

"This has an important bearing upon some forms of deviation with which we have to deal." "Observations indicate that the tendency of a single eye, when at rest, is to swing from the primary position—sometimes inward, or more frequently outward, or outward and upward." "We constantly find, in practice, a slight degree of latent convergence or esophoria." "In sleep, the eye assumes a position of up and outward." Blind eyes, it is said, "almost invariably turn outward," but this is not quite true. The examination of 21 pupils of the N. Y. State school for the blind, showed that there were almost as many of abnormal convergence as of divergence. "We must conclude therefore, that the monocular position of rest seldom corresponds to the primary position."

ACCOMMODATION.—Range of accommodation indicates "the amount of accommodation of which an eye is capable." When Test Letters are well constructed and reduced to proper size, it is much more convenient. The many methods of investigation of the pupillary reaction are so poorly adapted to clinical use that practitioners do not avail themselves of them. In youth, 15 to 20 years, the pupil is about 4.1mm and at 50 years, about 3mm. The main causes which produce changes in its diameter are—1st. Intensity of illumination. 2nd. Act of accommodation contracts. 3d. Size relates to respiration and circulation. 4th. "Varying conditions of the nervous system—especially those involving the sympathies, fear, surprise, emotion" and the more lasting changes from lesions of the motor oculi. He uses a modified microscope with a micrometer eye-piece.

ASTIGMATIC.

IRREGULAR CONTRACTION OF THE CILIARY MUSCLE.

From the irregular action may be established—1st. Facts of anatomical arrangement—2nd. In other muscles exact measurements show a different degree of tension of different fibres—3rd. "Certain branches of the 3d nerve are sometimes paretic or 'insufficient, leaving muscles supplied by other branches in an entirely normal condition.'" 4th. The action of the ciliary to overcome astigmatism in the consulting room, contradiction is found between the declaration of the patient, on looking at the charts, and what is found by scientific examination. 5th. Sensation of the patient, headache, and its relief on correction.

ONE EYE IN MOTION.

NOMENCLATURE.

Adduction.	Intorsion.
Abduction.	Extorsion.
Superduction.	True torsion.
Subduction.	False torsion.
Cirsumduction, or	Cycloduction.

Ophthalmotropes are models of mechanisms to produce the motions of the eyes and in great variety. It assists the teachers in conveying the fundamental ideas concerning the movements of the balls by the ocular muscles. "All the points, which an eye can see or fix, while the head remains immovable, constitute the field of fixation or the motor field." "Most physiologists and clinicians have depended on the perimeter for measuring this. "It is important to remember that the limit of the field of fixation is not to be judged entirely by the number of degrees which an eye can turn in any given direction. Much also depends upon the *manner* in which that motion is made." We wish to know, for instance, in abnormal convergence:

- 1st. Does any deviation of one or both eyes exist?
- 2nd. Which eye—if either, is specially affected?
- 3d. Exactly which muscle or group of muscles is affected?
- 4th. Is the deviation due to excessive contraction of the adductors, (action esotropia) or to paresis of the abductors (passive esotropia) or is it due to both causes?"

As to the 1st. Deviations are not always apparent—they may be latent and this is shown sometimes by the behavior of the eye as it approaches the limits. 2nd. "Most of the tests with double images.....do not show which eye" has the difficulty. 3rd. The limits of field assist in locating the group of muscles or even the principal muscle. 4th. It is difficult to decide and require aid in other ways. The lifting power of the adductors, when looking at a distance, averages about 18 grams. This should not be confused with the tensile strength—that is the weight which a muscle will sustain without breaking—2 to 2 and 14 -Kilos which is several times greater than that of the ordinary muscular fibre." The rapidity of the lateral motion of the eye as found by *photograms* is that it requires fifty to sixty thousandths for 30 degrees, and about 100 thousandths for one 100th of a second for 100 degrees. In the act of reading from left to right, the eye stops four or five times for perhaps 5 or 10 thousandths of a second. The movements of the eye, while reading, are shown by the photogram—at the

end of the line the eye rests for a varying length of time, then swings back to the left and begins again.

In winking the average time taken is about a half second. The time of remaining closed is about two to three tenths of a second. The lid is raised more slowly than it is closed—occupying from one to two tenths of a second. When one eye is slower than the other in its movements, it may be the first indication of a muscular paralysis. A wheel motion of one eye only is possible, but is unusual and is of no practical importance. Contrary to Maddox in regard to the silence of the eye muscles when in motion, Herring is quoted as saying, “that several proficient auscultators were able to tell when the eyes were looking at a distance or converging, by the sound produced.”

DIVISION 1.

BOTH EYES AT REST.

The relation of one eye to the other and the fundamental principle, which controls all associated action, must be taken into account. As nature abhors a vacuum, so is the desire for single vision. “The associated motion of two eyes requires, first of all, that the image of an object looked at, shall fall on parts of the two retinas which correspond to each other.” The measurement of the interocular base line, which is the distance between the centers of the eyes, or pupils of the eyes, is a practical necessity for several reasons. The Primary position is when the visual axes of the horizontal plane are parallel to each other and perpendicular to the line joining the centers of the two eyes. The different forms of heterophoria are, “essentially, passive conditions.” When we “disassociate the retinal image in one eye, from its fellow eye, each globe tends to swing into the position most natural to it.” Then if single vision is maintained in heterophoria, it requires a constant effort of one or more groups of muscles to maintain single vision.

The essentials for examination are—room, of six meters in length, darkened, and light placed at six meters or more. A candle flame is inconvenient and inaccurate, but if used, should be inclosed in an opaque cylinder, with circular spring on one side, and a head rest to keep the head in proper position. The Maddox rod is an admirable test in many respects. A Phorometer in connection with head rest is necessary for exactness.

DIVISION II.

CLASSIFICATION OF TESTS.

1ST. GROUP.

1st. Displacement of the clear image of one eye, up or down.

(a) As Von Graefe's single prism, base up or down.

(b) Stevens, Savage and others—two prisms, one base up, and the other down—one over each eye.

(c) Maddox double prism, bases joined.

2ND. GROUP.

The image is clear in one eye, but in the other is so disturbed or blurred that the desire for vision is abolished.

(a) Maddox rod. (b) Stenopaic Lens. (c) Cobalt glass.

3RD. GROUP.

The Screen test—blinding one eye and noting whether the eye screened swings away to another point of rest.

Instruments must be constructed so that they can be arranged exactly in the same position. Much greater exactness is necessary before we can lessen materially the existing confusion concerning muscular statics. The ciliary muscle is an important factor in determining the position of the visual axis. In hypermetropia there is some tension of that muscle in seeing distant objects clearly. Results will be less conflicting if atropia is used and a correction of the refraction is made. "The recti muscles influence the static condition of the visual axes, for after atropia and correction of ametropia there is movement. The condition of the retina influences this also, for it is sometimes difficult for individuals to perceive the image."

The so called "Position of Rest" is either *apparent*, which is simply a relaxation, more or less complete, of the extra ocular-muscles, or *actual*, which is relaxation of both intra-ocular and extra-ocular muscles. The results obtained in examination of large numbers of persons were striking in showing that orthophoria was by no means necessary to comfortable vision as had formerly been supposed. The methods ordinarily used for determining the static position of the visual axes are not altogether satisfactory.

DIVISION III.

POSITION OF THE VERTICAL AXES.

There may exist a tendency of the vertical axes to revolve about the anterior-posterior axes. When the eyes are in a primary

position the vertical axes tend to diverge upward, at an angle with each other of about three degrees. The fact that the vertical axes do revolve about the anterior-posterior axes is important and what is called true torsion.

TESTS.

The double prism and elaborated by Savage.

The Steven's Clinoscope & Volkmann's Disks.

The adaption of Volkmann's Disks to Converging Clinoscope.

TEST FOR CYCLOPHORIA.

The double prism is the simplest and the most easily understood but it is not exact. The Clinoscope, with intelligent patients, is most exact. (One and one-half to two degrees, each eye.) By tipping the upper radius out four degrees to allow for the normal outward tipping—then count any variation as real cyclophoria. It is better to use the terms, outward and inward, than plus and minus.

BOTH EYES—ASSOCIATED MOVEMENTS.

The motions of one eye alone include much which relates to both. The two eyes may be regarded as the halves of a single organ. In order to avoid double vision, each eye instinctively turns its visual axis to the point to which attention is directed. Although the theories of the mechanism of the motor impulses relating to both of the eyes in the same direction, have been discarded, our knowledge of the functions of the cells in the muscles in different portions of the brain, has grown more exact. There are at least six conjugate innervations.

CLASSIFICATION OF ASSOCIATED MOVEMENTS.

1st. A torsional movement is made about the visual axis, which is the hub of the wheel motions. These motions are very limited but must be considered in connection with true torsion, which accompanies convergence. They are a cycloduction-active. Many devices have been made to measure. The method of Herring is described as simple—Donders' Isoscope—his own, using the Maddox rod principle. The Maximum and Minimum extorsion and intorsion is found to be in a limited number examined—Maximum extorsion 4° and Minimum intorsion $2\frac{1}{2}^{\circ}$ The Maximum extorsion and intorsion are often more than twice as much as the Minimum, and vary greatly in different persons. The importance of this study is variously estimated. "The evidence is abundant where

the axes of astigmatism approach each other, but are still sufficiently divergent to produce this effect at torsion. That condition is a very important cause of asthenopia, although the degree of astigmatism be slight."

2nd. "The parallel visual axes move in one of the principal meridians to the right, left, up or down. There is no torsion. The clinical bearing in this connection is with the double images in paralysis."

3rd. The parallel visual axes move obliquely. The vertical and horizontal axes *appear to change* their position, called "false torsion," by Maddox. Before him, it was described simply torsion. It is not a true wheel motion, as shown by detailed descriptions by different authors. This also has a bearing in cases of paralysis.

4th. The visual axes do not remain parallel but converge. In doing so the upper end of each vertical axes rotates slightly outward, producing true torsion.

CONVERGENCE is the most important group of motions with which we have to deal, as it is accompanied with a certain amount of Accommodation, and of true torsion. We now estimate it by the meter angles of Nagel. He gives a table of the degrees of convergence expressed in meter angles of the different pupillary distances from one to twenty degrees.

THE RELATIVE FUSION POWER OF THE MUSCLES.

The power of the abductor muscles is found by placing prisms, base out, before one or both eyes, the effort being to avoid double vision. One or both eyes turn in. As this effort is one exerted in relation to the opposing groups of muscles, we can properly call it the relative power of adduction. It depends upon two factors; the actual strength of the recti muscles and the so called instinctive desire for fusion. Both of these vary in different individuals. The same principle applies to all ductions.

HOW TO MEASURE FUSION POWER.

If the parallel visual axes are directed to a distant object, and a prism is held before the right eye with the base out, then, as the ray from the light passes through the prism is deflected towards its base, the image of the light falls not on the fovea of the right eye, but on its outer side and crossed diplopia results; with an instinctive desire to overcome it, the eye turns far enough inward to overcome the diplopia; with a stronger prism the eye turns

in, and still more until the strongest prism is reached which the adductors can overcome., which is said to represent the power of adduction of that pair of eyes. We are very far from agreeing on the interpretation of the data obtained by this simple procedure. We have most confused the idea of how the power of adduction should be measured—what its amount is in normal conditions, and what its value is clinically, and indeed whether such examinations have any value at all.

METHODS OF EXAMINATIONS.

Let us begin by placing a prism of five degrees ,base out before the right eye. Suppose the eye overcomes this prism and others of gradually increasing strength, as they are selected *from the trial case* until we find at last that one of nine degrees represents the total abducting power, or we may begin with prisms of 12° or 14° , taken again from the test case and decreasing from that point, find again that one of nine degrees is the strongest which the adductor muscles can overcome. If however, we vary that method of testing, by gradually increasing the strength of the prism, *without allowing the eye an interval in which to rest*—the result is different. If we use the prisms in series, the adduction can be brought to ten or twelve, and if we use rotating prisms, adduction can be brought to fifteen or eighteen, and occasionally greater. Evidently, we have different results, dependent upon different methods.

1st. The Minimum relative of fusion power of a group of muscles, is that which we obtain by placing different prisms before the eye, leaving a considerable interval between the tests, or it is that which is found when we pass from a prism strong enough to produce diplopia to one which can be overcome.

2nd. The Maximum relative of fusion power of a group of muscles is that which we obtain when we pass, by gradual increment, from a prism, which is not strong enough to produce diplopia to one which cannot be overcome. It may be observed that this "development" of the latent heterophoria is something which may be done by almost any one who has abnormal eyes, if he will take the trouble to use prisms of increasing strength, regularly and patiently, even for a comparatively short time. Such experiments, on normal or abnormal eyes, show how readily the muscular power can be increased, and indeed, no limit within the bounds of credulity, seems to have been placed on the power of fusion. In a word, the maximum of fusion power is of some interest for the sake of comparison, but certainly is not of as much importance in itself, as many writers on the subject would have us think.

BALANCE OF POWER.

It should not be inferred that relative weakness in a certain group of muscles, as measured in terms of prisms, is an indication of inability of that group of muscles to do its work in a physiological manner. In different individuals whose eyes are practically normal, the minimum power of adduction, for example, may be quite small, occasionally only half the average, but in these individuals we find, ordinarily, that the minimum power of the opposing group is also less than normal, and often in a corresponding degree. On the other hand, there are individuals who have a minimum power of adduction largely in excess of the average, and in these we are apt to find a correspondingly large amount of abductive power. In other words, it is certain that in the normal condition, we may have decided variations in the relative strength of different individuals, but that the balance between the opposing groups of muscles remains, in a general way, the same. A pair of scales will balance whether there is a weight of the grains or a hundred grams on either side.

TEST OF BALANCE WITH CONVERGENCE.

For distance heterophoria is as frequent as orthophoria. That is not the case when accommodation and convergence is brought into action.

Test of Von Graefe—dot and line. When the individual sees only one vertical line with two dots in its course, we say that "muscle balance exists for that point, whether it be three, four or five meter angles of convergence. This condition is often described as orthophoria at the near point. That term, however, is both contradictory and indefinite. If orthophoria is a "tendency of the visual lines in parallelism, evidently that cannot occur in convergence If the two dots are not in the same vertical line, they can be made to appear so by placing a second prism at right angles to the first, as when correcting a heterophoria. The position and strength of the second prism then shows the kind and degree of heterophoria, which exists with convergence at a certain number of meter angles, whatever that may be.

STEREOSCOPES. The Stereoscope is of decided assistance in treating certain forms of muscular difficulties.

DIVISION III.

THE RELATION OF ACCOMMODATION TO CONVERGENCE AND RELATIVE ACCOMMODATION.

The range of Accommodation—the relative accommodation—the plotting of relative accommodation—how the range of relative accommodation is influenced by age is minutely handled and described.

DIVISION IV.

RELATION OF CONVERGENCE TO ACCOMMODATION—RELATIVE CONVERGENCE.

The Clinical Importance of the Relations of Accommodation and Convergence will be met at every turn and no phase of our subject is worthy of more careful study.

DIVISION V.

RELATION OF BOTH ACCOMMODATION AND CONVERGENCE TO TORSION OR TRUE TORSION WITH CONVERGENCE.

The relation of Torsion is elaborately defined and the measuring is fully described. Torsion is one of the three factors which contribute to comfortable vision at the near point. Relation of both Accommodation and Convergence to Torsion with Convergence. "Torsion with convergence is the tipping outward of the upper ends of the vertical axes (true torsion) which accompanies convergence.

APPLIANCES.—"It is necessary to distinguish different instruments for measuring the tipping of the vertical axes." Those which measure the cyclophoria, which is a passive condition—tortometers which measure the cycloduction. "Most of the Tortometers are also Clinoscopes, but all Clinoscopes are not Tortometers."

The determination of the plane in which the visual axes lie is desirable. Le Contes' method is the simplest. The tipping outward of the upper end of the vertical axes usually increases as the plane of the axes of vision is elevated and not in proportion to the amount of convergence. It is relative. The object of torsion is not clearly understood. When torsion is disturbed artificially—the effort at torsion, which the eyes make to fuse these lines, gives a sense of discomfort. It will be seen that torsion must be taken into account together with accommodation and convergence. Muscle Balance is (as defined) the condition in which, with comfortable binocular vision, accommodation, convergence, and torsion

bear their normal relations to each other. We need a physiological standard, with which to compare nervous forms of muscle balance, or unbalance as it is sometimes called. Muscle Balance is relative. It should not be confused with orthophoria.

MUSCLE BALANCE (EUKENESIS).

- 1st. Relates to extrinsic and intrinsic muscles.
- 2nd. Visual lines parallel or converging.
- 3d. Binocular vision must exist.
- 4th. Comfort is essential.

RELATION OF THE "GENERAL STRENGTH" TO THE PHYSIOLOGICAL ACTION OF THE OCULAR MUSCLES.

The power of the eye muscles is given in terms of prisms, whereas the condition of the muscles of the body is given in foot-pounds.

"When we take into account both the minimum and maximum power of different groups of the ocular muscles—for example, adduction and abduction—each measured by different methods, we have at least an approximate expression of the strength of the ocular muscles in that individual." "The muscular tone does not refer to the strength or lifting power it is the ability of a muscle or a group of muscles to perform the amount of work normally devolving upon them without the development of fatigue . . . there can be no question though, but that this normal tone of the ocular muscles is also in proportion to the tone of the muscles in other parts of the body of that individual. . . . It is true that we often find invalids, who can read and work all day under adverse circumstances." Where we find an imbalance or fault of the muscles, we should not be satisfied with local means only, but the strength or tone of the muscles of the body should be improved.

HOWE, VOL. II.

PART I.

OCULAR MUSCLE IMBALANCE.

The three primary forces in the act of comfortable vision have, each, a secondary one—"resistance". Balance is rare as perfect health, but it does exist. Where the primary and secondary factors bear their normal relations, we have balance or eukinesis. The range of variation without a sensation of real discomfort has been called, "The area of comfort." Imbalance is the condition in which accommodation, convergence and torsion do not bear their normal relations, called *dyakinesis*.

In the time of Von Graefe, what is now called heterophoria was called latent convergence and divergence. All latent abnormalities gradually came to be described by English and American writers as imbalance. It should be remembered that in all forms of eye strain—the ultimate cause of uncomfortable symptoms is the instinctive effort to obtain and to maintain perfect vision, and also binocular vision when that is possible. Of the various forms of imbalance, it is customary to speak of them as varieties of asthenopia. This is wrong and unfortunate—and “we shall attempt to dispense, when we can, with the term asthenopia.” We have a lack in our nomenclature, which includes anomalies of accommodation.

INTRA-OCULAR.

According to our modern nomenclature of the external muscles, this has nothing to do with the ciliary muscle. There is evident need and the single word, heterocykinesis, *hereto* (varied) *cycle* (as in cyclites) Kinesis (strength or tenacity) but we have the English terms, anomalies of accommodation, spasm and paresis (abnormal action of the intra-ocular muscles.)

EXTRA-OCULAR.

Imbalance of—We know these as latent deviations or heterophoria

Is esophoria due to excessive contradiction of the adductors or associated with excessive accommodation—that is—is it active esophoria an actual excessive convergence, or is it the tendency to deviation, dependent on some abnormal relaxitive of the abductors—that is—is it passive esophoria? If so, it would be a relative excessive convergence, so, in a similar manner with the other deviations, and of this proposition, he makes eleven groupings. Besides these, there are compound forms of imbalance—mixed simple imbalance, and an associated compound imbalance. Simple Imbalance, “is one in which there is an abnormal condition of only one of the principal forces or a pair of forces, which enter into the act of normal binocular vision.” Compound Imbalance, “is one in which there is an abnormal condition of two or more principal forces or pairs of forces. A large majority of all cases of imbalance are of the compound forms.” Imbalance should not be confused with its results.

“Eye strain is a result of ocular imbalance. A person may or may not be conscious of strain.” “Asthenopia is a group of symptoms—also a result of a muscle imbalance. The patient is conscious of it, often to a painful degree. We shall deal only

with those few symptoms, which all practitioners agree, do frequently accompany imbalance. These may be called the *cardinal symptoms*.

Blurring, frequently due to insufficient focusing.

Headache—varieties almost innumerable.

Location of—frontal, vertex, occiput, extending down the neck, even to the back.

Hyperemia of the conjunctiva.

Increased Lachrymation.

At the first visit, we should enter only a provisional diagnosis.

SIMPLE IMBALANCE INVOLVING ONLY THE INTRAOCULAR MUSCLES.

DIVISION I.

“ACTUAL EXCESSIVE ACCOMMODATION.”

In actual excessive accommodation, he unqualifiedly answers affirmatively that it is desirable to make a really exact correction of ametropia. In some cases, a persistent use of belladonna for months—even to six.

DIVISION II.

“RELATIVE EXCESSIVE ACCOMMODATION,” the treatment of this simple imbalance is by correcting the ametropia.

DIVISION III.

“ACTUAL INSUFFICIENT ACCOMMODATION,” find the cause and treat that and give a guarded prognosis. Bodily exercise is recommended, but ocular exercise is not mentioned.

DIVISION IV.

RELATIVE INSUFFICIENT ACCOMMODATION. It is the most important simple imbalance.

The insufficient accommodation is dependent upon, or relative to the resistance offered by the lens.

The range of accommodation is either normal or its action is limited—the positive part small—the negative large.

A sharp line of distinction cannot always be drawn between actual and relative insufficient accommodation—causes—Presbyopia—Hypermetropia—Astigmatism—Treatment is obvious—If discomfort continues—rest and Dyerism.

DIVISION V.

UNEQUAL REFRACTION (ANISOMETROPIA) TREATMENT-CORRECTION.
SIMPLE IMBALANCE INVOLVING THE EXTRAOCULAR MUSCLES ONLY.

(Simple heterophoria)

EXTRA OCULAR MUSCLES.

DIVISION I.

LATENT DEVIATIONS PRODUCED BY THE HORIZONTAL MUSCLES.

(ANOMOLIES OF CONVERGENCE.)

SUB-DIVISION I.—*Active esophoria or actual excessive convergence*, excessive action of adductors rather than relaxation of abductors. We frequently have, in normal eyes, a tendency of the axes to converge or diverge, when the individual looks into the distance, but when converging and accommodating, we have muscle balance. (eukinesis) Symptoms given are objective. Among the subjective are feelings of tension and panoramic fatigue.

Causes—Anatomical, Physiological, Central.

SUB-DIVISION II.—*PASSIVE ESOPHORIA (Relative excessive convergence.)* Visual axes tend to turn inward from lack of resistance of abductors. The abductors are easily fatigued. Frequency is not as great as the active form. The positive relative convergence—large and often irregular at different points and also different times. Causes may be anatomical—often paralysis, paresis.

SUB-DIVISION III.—*ACTIVE ESOPHORIA (Relative Insufficient Convergence.)*

This is a rare condition. Cause—some imperfect action of the abductors. Test—Von Graefe's dot and line test. TREATMENT—Rest is not here indicated, but strengthening convergence. The problem is how to make the adductors stronger than normal, in order to balance the excessive power of abduction. That is not easy to accomplish. A gymnast can develop the muscles of the arm, but with some difficulty and only to a limited degree. Some temporary relief from the discomfort can usually be obtained by abductive process, but when continued too long it makes matters worse. In this form of exophoria, advancement is warrantable. General treatment—medication and hygiene.

SUB-DIVISION IV.—PASSIVE EXOPHORIA (*Actual Insufficient Convergence.*)

The visual axes tend to diverge because of insufficient action of the adductors. This is next to insufficient accommodation in frequency. A differential diagnosis from the active, in many cases, is impossible. Objectively, the differential diagnosis can be made with the perimeter, tropometer, photograms. Subjective—there are abundant and varied forms of eye-strain—the cardinal symptoms always present. Sometimes we have an imperfect knee-jerk. Causes—anatomical—analogueous to those in relative insufficient accommodation—disturbance of the nervous system—over correction of strabismus.

Treatment—Exercise of the ocular muscles—Wall and wall exercise—Occasional strong prisms for a distance—ditto for near-stereoscope—weak prisms for constant use—decentering lenses—gradual and frequent strengthening of the wearing prisms.

DIVISION II.

LATENT DEVIATIONS PRODUCED BY THE OBLIQUE MUSCLES.

(ANOMALIES OF TORSION) CYCLOPHORIA.

SUB-DIVISION I.—EXCESSIVE TORSION. The frequency seems to be rather rare—perhaps because exact measurements of it are comparatively few. They are more frequent in relation to astigmatism, and more important than is usually supposed. Causes—Astigmatism. Treatment.—Correction of ametropia. As to exercise of the oblique muscles, thus far the results obtained have been of rather doubtful value.

SUB-DIVISION II. INSUFFICIENT TORSION.

The upper end of the vertical axis does not tend to turn outward as far as it should normally. Treatment.—Same as division I—with modifications.

DIVISION III.

SUB-DIVISION I.—LATENT DEVIATIONS PRODUCED BY THE VERTICAL MUSCLES HYPERPHORIA AND HYPOPHORIA.

When Hyperphoria is a tendency of one eye to turn up while the other fixes the distant object. Hypophoria is the tendency of the other to turn downward. To make a definite diagnosis between the two is not possible, and in the matter of treatment is of slight importance. The vertical symmetry of the face can be seen in

some—the eyes are not on the same horizontal plane and it is often rectified by tipping the head. We do not know whether the upward tendency is of an active or of a passive nature. **TREATMENT.**—Local consists in use of prisms, and not knowing whether the tendency to turn up is dependent on undue contraction of the levators or upon relaxation of the depressors—the placing of prisms is empirical. Operation is to be considered only as a last resort.

SUB-DIVISION II. ANOPHORIA AND KATOPHORIA.

Their number is exceedingly small and have not yet been studied with the care, which they perhaps deserve. The tendency to lower the chin and raise the eyes; the deleterious position of the head in its effect on respiration, (which Stevens gives) he thinks “is unworthy of serious consideration.” he considers it a bad habit and shows a lack of proper training. He suggests a prism, with base down, over each eye. Repetition is unnecessary in the opposite position of Katophoria.

COMPOUND IMBALANCE.

ANOMALIES OF TWO OR MORE GROUPS OF MUSCLES.

DIVISION I.

There are two varieties—associated and disassociated. “As a disturbance of a single one of the three pairs of factors is apt to also disturb the relation of one or more of the other factors, we may, apparently, have as many different forms of compound imbalance as there are permutations of six.” But, disheartening as the conditions may be at first glance, the treatment problem is not so complicated, for, “when we correct the principal abnormal element, the others associated, tend to correct themselves.” “Compound imbalance is not a disease, but only the name of two or more abnormal muscular conditions, each of which, is by itself distinct from the other.” One is called the excessive or spastic type—excessive accommodation and an esophoria or sometimes an excess of torsion. We should determine, if possible, the relative importance of each element in the compound imbalance. The imbalance of the intra-ocular muscles is usually more important than that of the extra-ocular. “A decided imperfection of torsion is usually of more importance than an imperfection of convergence.”

DIVISION II.

SUB-DIVISION I. EFFECTS OF THE INTRAOCULAR MUSCLES ON THE INTRAOCULAR STRUCTURES.

Prolonged effort of accommodation produces Cycletes, Iritis, pathological changes in Choroid, in Retina, Macula, Optic nerve. Eye-strain as a cause of Glaucoma is doubtful but it is claimed by some, it causes peripheral opacities in the lens.

SUB-DIVISION II.—EFFECTS OF THE EXTRAOCULAR MUSCLES ON THE GLOBE.—

No one can study the aspect without being convinced that the extra-ocular muscles do affect the form of the globe. It is generally agreed that astigmatism can be developed. The broad tendons of the recti and especially of the two obliques might press upon the globe to impede the return of venous blood and thus increase the ocular tension.

SUB-DIVISION III. EFFECTS OF THE OCULAR MUSCLES ON NEIGHBORING STRUCTURES.

Hyperemia of the Conjunctiva; associated with it a feeling of discomfort, itching or distant pain, which causes the person to close the lid and rub the eyes; increased lachrymation; corneal inflammation; blepharitis, associated with astigmatism.

Headaches.—Our ignorance on this subject is almost as great as it was a half century ago, depending on imperfect nomenclature. The locality of pain, its area, and whether that pain is accompanied by tenderness. "As there has been a decided looseness in using the term headache, so there has been a similar laxity in using the term eye-strain when related to that headache." We wish to know kind and degree of ametropia—imbalance." It is divided into three groups.

1st. Headache, the result of contraction of accessory muscles of accommodation.

2nd. Those which are directly the result of imbalance.

3d. Those which are a reflex from disorders of the stomach or other parts of the body.

Torticollis occur in some forms of imperfect action of the ocular muscles. Such an enforced position of the head, maintained for a long time, results in the condition we recognize as Torticollis or Scoliosis.

SUB-DIVISION IV.—EFFECTS OF THE OCULAR MUSCLES ON THE OTHER PARTS OF THE BODY. (*Indirect Effects of Imbalance.*)

They are probably produced through the sympathetic nervous system. Their importance has been unduly exaggerated—usually called, “reflexes of eye strain.”

“Donders,” and for some time after him, no one suspected that the action of the muscles would produce much inconvenience beyond the cardinal symptoms, which were then called asthenopia.” “Gradually, increasing clinical experience has modified our idea of asthenopia.” Symptomatology is enlarged beyond the cardinal systems, to “pain extending upon the neck and shoulders,” nausea including many reflexes of a neurotic type, dependent upon the use of the eyes. Many of these symptoms may result directly from an imperfect action of the ocular muscles, and also disturbances of the general system, acting on a primary cause, may affect the ocular muscles and are called asthenopia.”

REFLEXES.—The criterion to determine whether a given symptom is the result of muscle imbalance—we should establish—(a) “a relation in time—should follow the imbalance or be coincident with it;” (b) “there should be a relation in degree; ordinarily the amount of imbalance is in some proportion to the severity; the severity of the reflex is sometimes entirely out of proportion to the amount of imbalance;” (c) “the partial or total correction of the imbalance should produce a corresponding effect upon the reflexes;” (d) “everything which may be considered a contributing cause in producing reflexes should be eliminated.” “The frequency of such reflexes—especially in America, is noted by many.” Americans use their eyes in a careless manner. The hurry and mental strain make unusual demands on the nervous system. “Reflexes are due to difficulties of digestion.” “Heat and dryness of the atmosphere in our homes cause Conjunctivitis and thus give rise to symptoms of imbalance.”

SUB-DIVISION V.—EFFECT OF THE OCULAR MUSCLES ON THE NERVOUS SYSTEM.

HEADACHES.—Indirectly the result of Imbalance.

SICK HEADACHE (migraine) belongs to this group. The literature of late years has grown large in which the remedy has been correction of the refraction. FATIGUE, easily brought on by use of eyes..

NEURASTHENIA.—Imbalance of the ocular muscles, with the resulting eye strain, is one of the causes which we class together

under that one name. That eye-strain is usually a prominent cause, and occasionally the only cause, is an extreme view.

HYSTERIA.—The limbo of Neurotics, and the unreliable statements of them is depicted.

CHOREA. The off-hand statement, frequently made, that chorea is always or even usually due to ocular imbalance, "is not supported by fact." There are a few cases in which the relation between eye-strain and chorea is, apparently, that of cause and effect. To condemn any patient to glasses, the evidence must be as conclusive as possible.

EPILEPSY.—The term means nothing exact. "It is certain that some cases show a distinct relation between muscular imbalance and epilepsy." In a small number of cases, the attacks are lessened by suitable glasses.

OTHER NEUROTIC CONDITIONS.—The literature is abundant. The nervous effect on the mental and moral conditions, the chain of circumstances is far from complete.

SUB-DIVISION VI. EFFECTS OF THE OCULAR MUSCLES ON PARTS OF THE BODY OTHER THAN THE NERVOUS SYSTEM.

On the teeth; on the mucus membrane of the nose; on the stomach. The effect of extra effort at focusing or movement of the eyes, as in a car, swing, or with some, when at sea, or use of glasses on normal or abnormal eyes, affecting the stomach, is in evidence. It was proved by a case of gastric fistula, that the acerbity of the stomach was affected by certain glasses. On certain parts of the body; the heart, the liver, the kidneys, it is doubtful whether the glasses, which were thought to improve these condition, did more than relieve some existing eye-strain, and thus directly comforted the patient.

EXAGGERATED OPINIONS OF THE EFFECT OF EYE STRAIN.

If we admit that certain reflexes can be produced by imbalance, the question arises why all reflexes do not come from the same cause. Some of these cases of nervous reflexes are cured by the adjustment of glasses or by certain operations, but in most cases they are not. Exaggerated statements have been made in late years to prove, that well known authors have been sufferers from eye-strain, and that their misanthropic views, indigestions or ill temper, were due to imperfection of the ocular muscles. It seems a little hasty, to say the least, thus to jump at a diagnosis, when the

patient has been dead for many years. Such literary diversions are clever and popular of course, but let us not call them, even semi-scientific or attempt to treat them seriously.

DIVISION III.

REFLEXES TO THE EYE FROM DISTURBANCES IN OTHER PARTS OF THE BODY.

These have been called "Central Asthenopia." There is nothing to show that any of these reflexes are "central" in the sense that they are due to changes in the brain.

SUB-DIVISION II. REFLEXES TO THE EYE, SHOWN AS SYMPTOMS OF IMBALANCE.

CONJUNCTIVITIS.—We must not allow our knowledge of refraction or of muscle imbalance to make us forget that these symptoms may be the result of a simple conjunctivitis and is to be treated as such. Ocular headaches are of entirely reflex character. These are not dependent upon muscle imbalance. Ocular headaches cause disturbances of the stomach, as for instance, a distinct discomfort just above the eyes, when cold is taken into the stomach. In some cases the gastric condition produces, not simply reflex symptoms, but also a distinct imbalance.

From disturbance of the intestinal canal.

From imperfect nutrition and from toxæmias.

In anaemic or chlorotic cases.

Headaches from toxæmias.

When a patient complains of ocular headache, which glasses fail to relieve promptly, it becomes the duty to have a reliable examination made of the blood or of the contents of the stomach, or have the urine tested, and, if necessary, an examination made of the blood pressure.

Reflex to the eye from the nose.

Reflex to the eye from the ear.

Symptoms of Imbalance after injury.

Non-Traumatic Nerve Lesions.

Splanchnoptosis.

SUB-DIVISION II. REFLEXES TO THE EYE FROM IMPERFECT NUTRITION, INTOXICATION, ETC. SHOWN AS ACTUAL MUSCLE IMBALANCE.

Distinct Imbalance is produced by imperfect nutrition, intoxication or by some disturbance of the function in another part of the body.

DIVISION IV.

SUB-DIVISION I. TREATMENT OF COMPOUND IMBALANCE.

A. Correct any Intra Ocular Imbalance.

B. The correction of any imbalance of the Extra Ocular Muscles by prisms or by decentered lenses, affords, at least, temporary relief by placing them in such a position as to favor the affected muscle. Usually, it is preferable to turn the prism in the opposite direction if the best ultimate results are desired.

C. "In Associated Compound Imbalance, if we correct the function or feature of the imbalance, then the muscle balance or at least improvement follows."

D. "In some cases of associated and in nearly all cases of dissociated compound imbalance it is necessary to deal with each compound function or feature of the imbalance according to the principles of simple imbalance."

SUB-DIVISION II. RECOGNITION AND TREATMENT OF GENERAL CAUSES OF IMBALANCE.

Anaemia and Tests of the Blood.

Auto-intoxications and tests of the Urine.

Auto-intoxications—especially with sick-headache and tests of the stomach contents.

Headaches and other symptoms of Imbalance and Tests of the Blood Pressure.

SUB-DIVISION III. SIMPLE FORMS OF GYMNASTIC EXERCISE.

(Condition of the muscular system as a whole and Ocular Muscles.)

SUB-DIVISION IV. THE OPTICAL TREATMENT OF MUSCLE IMBALANCE BY THE OPTICIAN OR BY THE OPHTHALMOLOGIST.

PART II.

ACTUAL DEVIATIONS DUE TO LESIONS OF THE EXTRA OCULAR MUSCLES OR IN THE GLOBE.

DEFINITIONS.

"When the visual axis of one eye fixes a certain point, the fellow eye is directed to some other point. This describes an *Actual* and *Manifest* deviation as distinguished from forms of heterophoria, in which there exists only the *tendency to* deviation. These actual deviations, usually called "Strabismus" or "squint" are now termed "Heterotropia.". This we use as a synonym for "deviation. Deviations are paralytic or non-paralytic.

SYMPTOMS AND DIAGNOSES.

DIVISION I.

DEVIATIONS AND THEIR MEASUREMENT.

The Linear Strabometer.

The Strabometer of the author. (Howe)

Corneal Reflexes. Maddox Rod.

With Flattened Perimeter.

The Tripometer.

The Production of Diplopia.

Photographs.

DIVISION II

SYMPTOMS OF NON-PARALYTIC OR ACTIVE DEVIATIONS.

One in which there is no evidence of a subnormal action of the muscle or group of muscles, away from which the visual axis deviatesdue more to excessive action of one muscle or group of muscles than to insufficient action of the opponents." The degree varies greatly. It may be primary or secondary. It may be permanent or variable.

DIVISION III.

ARRANGEMENT OF DATA AND PLAN OF STUDY. SINGLE LESION WHICH PRODUCE ACTUAL NON-PARALYTIC DEVIATIONS.

(SIMPLE HETEROPHORIA.)

DIVISION I.

DEVIATIONS DUE TO ABNORMAL MUSCLES.

Muscular heterotropia is an abnormal condition of the Extra Ocular muscles, which produce deviations of the globe, but in the majority of cases, the original cause of the deviation is not an excessive or insufficient action of the muscles, but is owing to some imperfection of the globe. "Typical examples are rare."

SYMPTOMS.—These are neither numerous nor reliable. By exclusions' process we may say, there is an hypertrophy or shortening of one group of muscles or atrophy or lengthening of the opposing group. Often there is little or no ametropia. To assume that these cases are from a defect of the fusion faculty "is simply begging the question." There are certain facts which indicate that these deviations are caused by anatomical variations, from the normal type.

TREATMENT.—Determine whether active or passive. Then if good vision is present, muscle exercise can be practiced to advantage. When such exercise is not practicable, operation is the only treatment available.

DIVISION II.

DEVIATIONS DUE TO AMETROPIA.

SUB-DIVISION I. HYPERMETROPIC ESOTROPIA.

(Strabismus or Squint.)

As Donders taught, and others subsequently have proved beyond question, ametropia is a cause of deviations inward. By separating this group from others, the pathological conditions can be well defined and treatment better understood.

SUB-DIVISION II. MYOPIA EXOTROPIA.

Resulting from a myopia, with or without Astigmatism.

Pure types, rare. Usually secondary changes in the retina.

DIVISION III.

DEVIATIONS DUE TO IMPERFECTIONS OF THE RETINA.

DEFECT OF THE FUSION FACULTY-AMBLYOPIA IN THE RETINA OR
IN THE BRAIN.

DIVISION IV.

DEVIATIONS DUE TO IMPERFECTIONS OF THE REFRACTIVE MEDIA.

Opacity of Cornea.

Superficial Cicatrix from Ulceration, etc.

DIVISION V.

SOME SECONDARY CAUSES, WHICH MAY CONTRIBUTE WITH ANY
SINGLE LESION TO PRODUCE A DEVIATION.

Occupation, Irritation, Anisometropia, Heredity.

DEVIATIONS DUE TO TWO OR MORE LESIONS.

(COMPOUND HETEROTROPIA.)

MUSCULAR LESIONS. Abnormal condition of the Extra-ocular, is in many cases the underlying cause....Amotropia, Imperfect Retinal Perfection

TREATMENT. For the non-operative it is to correct the ametropia, improve the amblyopia, and strengthen the weaker muscles, but to follow this as a routine plan, we found neither scientific nor satisfactory.

PART III.

ACTUAL DEVIATIONS DUE TO LESIONS, IN THE BRAIN
OR IN THE NERVES.

PARALYTIC.—Ophthalmoplegia (Hutchinson).

Ophthalmoplegia interna—paralysis of all the nerve fibers, supplying the tissues on the interior of the globe, while the term Ophthalmoplegia externa was used to designate those cases in which “all or most of the muscles which move the globe” were affected.

DIVISION I.

SYMPTOMS AND DIAGNOSIS.

Summary. (Compare with Landolt.)

DIVISION II.

AIDS TO DIAGNOSIS.

DIVISION III.

DIFFERENTIAL DIAGNOSIS IS BETWEEN THE NON-PARALYTIC,
(ACTIVE) AND THE PARALYTIC (PASSIVE) DEVIATIONS.

In view of an operation, it is necessary to know how to decide, whether a tenotomy or an advancement.

PARALYSIS OF THE THIRD NERVE.

I. Cerebral Lesions.

II. Basilar Paralysis.

III. Orbital Paralysis.

IV. Peripheral Paralysis.

Peripheral Paralysis of the Third Nerve.

Paralysis of the Fourth Nerve.

Paralysis of the Sixth Nerve.

Paralysis of branches of the Sympathetic.

CAUSES OF OCULAR PARALYSIS.

PROGNOSIS.

TREATMENT.

PART IV.

ATYPICAL MOVEMENTS OF THE EYE. INFLAMMATIONS
AND INJURIES OF THE MUSCLES.

ATYPICAL MOVEMENTS.

DIVISION I.

- 1st. Definition.—Movements which do not seem to be related, in any way, to the deviations we have considered.
- 2nd. Voluntary Movements of one eye.
- 3d. Refraction Movements of the Eyes.
- 4th. Atypical Associated Muscle Action.
- 5th. Hysterical Deviations.

DIVISION II.

INFLAMMATIONS AND INJURIES OF THE MUSCLES.

Rheumatism, Myosites, Progressive Atrophy, Injuries of the Extra-Ocular Muscles.

PART V.

OPERATIONS ON THE MUSCLES.

PART II.

MONOGRAPH

BY

E. H. HAZEN, M. D.

ASTHENOPIA AND EYE STRAIN.

PHILOLOGY.

The Philology of a subject often gives the best history of its development and leads toward an understanding of its nature.

The gradual change in the definition of the word *asthenopia* from an "affection of the retina," as it was regarded when Donders came upon the stage, and his transferring the mystery of the phenomena to the function of accommodation as a cause, is an epoch in the science. From his time until near the present, the word designated a disease and it was placed at the heads of chapters and then belonged to the glossary of disease, (as by Stellwag and Noyes) but it did not stay there long for the word as it appeared in the later writings of the time, was used, as it now is, to designate a symptom. The most modern writers now use it thus and some do not dignify it with a definition, but use it as they do the words "pain and discomfort,"

Of late years, the term "eye-strain" has arisen and has become more general in use and it now, not only, conveys the idea of pain or discomfort but points to the underlying cause, and this substitution of the description of the cause of the trouble complained of, has come into quick use because of its less scientific ring than that of *asthenopia*. Many writers use the terms synonymously. The definition of these words by different authors, as they have come down to the profession, will show the insight its members had into this most prominent affection of all eye troubles.

In addition to what we have already laid out in the synopsis of asthenopia, we add the following:

Howard (1850) defines it as amblyopia or weakness of sight. He considers it as arising from constitutional causes.

Mackenzie, (1855), Asthenopia is "an incapability of sustaining the adjustment to near objects."

Jones, (1863), Asthenopia is "weakness of sight;" "debility of apparatus of adjustment to near objects."

Macnamara, (1876), A feebleness of vision from defective or irregular muscular action; the internal rectus being at fault in motor asthenopia, and ciliary muscle in the accommodative form of disease.

Schell, (1881), Asthenopia is a word used to express forms of pain. There is Muscular Asthenopia, in Myopia from strain of internal recti during forced convergence.

Mettendorf, (1881), "After using the eyes for near objects for some time, a weakness of one or both internal recti muscles becomes manifest. The weakness may be caused by efforts of convergence, especially from change of shape of the eyeball, or it may result from severe constitutional disease."

Ranney. *Nervous Diseases*. (1888), "Asthenopia is that condition of visual apparatus which entails suffering in consequence of defective equilibrium in the muscular power exerted upon that organ, when a fixed position of the eye is maintained for any length of time. The patient may or may not have refractive error."

Ranney, in *Eye Strain*—(1897), In this work he does not define the word.

Swanzy, (1897), uses the word in a general sense—hurting on use of eyes at near work. Conjunctival, Insufficiency, Nervous, Muscular—Muscular is caused by insufficiency and is a disturbance of the equilibrium.

De Schweinitz, (1892), uses the word without special definition. He recognizes Accommodative, Muscular and Neurasthenic Asthenopia.

Fuchs, (1899), recognizes Accommodative, Muscular and Nervosa, associated with near work, and "panorama" asthenopia" distant.

Jackson, (1900), does not define asthenopia or eye strain. He uses them synonymously in describing symptoms of disordered function and names eye strain "as cause of many diseases and confines the term of asthenopia to the pain and discomfort of the eye in functioning.

Fox, (1904), defines asthenopia as "a technical name for a group of symptoms resulting from eye strain due to errors of refraction or fatigue of the ocular muscles."

Berry, (1905), "Asthenopia is a name generally given to the inflammatory pain associated with the use of the eyes, which literally means a want of power in the eyes to perform their functions."

Ball, (1904), uses the word asthenopia as a symptom and recognizes accommodative, Muscular and Neurasthenic asthenopia.

Eye Strain. The use of the term "Eye Strain" is becoming almost universal in describing affections of the eyes, resulting from the functional use of these organs. Some of the former authors, however, ignore the word and use asthenopia instead, and some use them interchangeably.

The term, "Eye Strain," is not in the vocabulary of Mackenzie, Donders, Howard, Stellwag, Wells, Metten-dorf, Schmidt, Rumpler, Macnamara, Williams of Boston, Schell, Fuchs, Landolt, Roosa, Berry, Ball, de Schweintz, nor in Billings' dictionary.

Gould says, "Eye strain is the name given to any unphysiologic, i. e., pathologic ocular action or function which is wearing, excessive or unnatural. *Popular Science Monthly*. Dec. 1905.

It seems at present that the consensus of opinion is to regard Eye strain as expressive of the trouble of the eye in functioning, and Asthenopia as the principal symptom of pain and discomfort connected therewith.

If the word Asthenopia is held closely to mean the symptom of pain or discomfort arising from the eye, wheresoever that symptom is located, we have a very expressive and satisfactory word.

In the synopsis which I have given on this subject, and which I have attempted to elucidate, by quoting freely from well known authors, it can easily be detected that authors are drifting away from the former method of studying the phenomena we now call *Eye Strain*.

They have, in these latter days, gradually dropped the descriptions of the numerous symptoms connected therewith, as we find them in Donders and Noyes and seek other methods as a guide to ferret out the mischief these disorders present.

Since Donder's doctrine that the physiological cause of asthenopia existed in the ametropic condition of the accommodative apparatus, and especially since the admission that the motor apparatus of the extrinsic muscles participates, and since it is conceded by some that they may wholly be the seat of the trouble, there has been built an extensive theory of a mechanical nature rather than a physical condition to account for the departure of this apparatus from the normal.

In other words, the attention is directed to the position, direction of movement, results of action, deviations from standards of position and action, and the measurements of all these, instead of a study of the causes that have brought these conditions about. They seek to remedy these wayward "end organs" by adjusting them to their ideals, rather than by the consideration of the psychical forces that control and bring into creation

the sense of sight and keep it in repair for the best service.

The method of study, so long practiced in general medicine of noting symptoms and grouping these to direct the course of investigation is being dropped and the foot rule, the scale, the motion indicator and the balance are used to explain. These modern methods which call in the microscope and the test tube in many diseases, do not seem applicable to the diseases which we are now considering, for these belong to the nervous system and their connection is with the brain; they produce phenomena of a disordered action and a mental outlook that is difficult to understand, and is beyond measurement and borders on mystery, and though it takes such a hold on life and is so intangible in character, is yet exceedingly veritable, and afflicts a large percentage of the intelligent part of the community.

BALANCE AND EQUILIBRIUM.

We see by reference to our coterie of Authors, that up to the time of 1890 when Dr. Noyes wrote his last large work, there had not been anything said about imbalances.

About this time, Dr. Stevens gave to the profession his nomenclature with its system of measurements of the relation of the two balls to each other, and his instruments of precision. He also made more emphatic the importance of the strength and action than had been made before his time and that of Dr. Noyes.

Ranney, (1888), who was a student of Dr. Stevens, used the word balance in a foot note in defending their doctrine of "latent insufficiency" and he uses the word equilibrium in a general sense but not in so specific a sense as it has been used of late.

From about this time for a decade, Ophthalmology has been re-written on the basis of what Stevens gave to the subject.

The direction thus taken was that of considering the cause of trouble in this organ to be in the findings there—mal-adjustment, misfit muscles and corkscrew motions of the balls.

It is perfectly logical to consider symptoms as a minor and subordinate matter if this way of looking at it is the true one; symptoms will vanish when the ideal equilibrium is restored and balance is brought about. But in this conception of the situation we are losing the guide of symptoms to a physiological regulator.

A number of books have appeared which deal with the subject in this way. Since muscular disorders have been acknowledged to be a cause of asthenopia, a system of interrelation of the intrinsic and extrinsic muscles has been well worked and the principal physiological phenomena found in this conception is, that the abnormal imbalance of the extrinsic muscle has, for its explanation, the abnormality of the intrinsic muscles. This gets no farther than Donders.

At the risk of being considered "prolix," let us examine this doctrine of "balance", "equilibrium" and some other associated ideas that have relation to the motor apparatus and its anomalies.

The work of Dr. Stevens, which gave us a system with a definite basis on which to found a proper examination of the muscles of the eyes and their relations to each other, was a master stroke on this subject.

Before that, the study was prosecuted at the near point, entangled with the ever varying relation of accommodation and convergence.

Examination at a distance of 20 feet gives the best point at which to obtain rest of the organ in its functional action. At this point from which, practically, the rays

of light come parallel, it is seen that the eye must be examined to ascertain whether there are departures from this ideal point of rest.

The eyes do not always remain at rest, for it is difficult "for individuals to permit the eye muscles to become entirely passive." "Notwithstanding the imperfection of the theory, we possess no method of investigation better than producing diplopia of the image at this distance." "No just appreciation of the muscular balance can be arrived at, while the accommodation is considerably exercised or while convergence is required." (Stevens).

The new conception of "balance or equilibrium" took hold of the profession in the decade of the '80's and writers on Ophthalmology hurried to re-write their papers and books on this new basis.

Dr. Stevens says, "equilibrium should signify a condition in which all the muscles of the eyes are so proportioned and adjusted in respect to their dynamic conditions that, with the least expenditure of nervous energy, when the gaze is directed to an object in the median plane at the level of the eye and at infinite distance, while the head is in the primary position, the visual lines should be parallel and in the same horizontal plane."

He does not use the term "balance" in his "Motor Muscles" but in his contribution to System, the title of which is, "The Principles of and Methods for the estimation of the Balance of the Extra-ocular Muscles." In this article he says, "the best muscular equilibrium, that is the condition in which parallelism of the visual lines is maintained with the minimum of nervous effort, the condition is known as *Orthophoria*. (Vol. II.)

Landolt, in "Refraction and Accommodation" does not use terms balance or equilibrium, but in System (1900) says, "The position of equilibrium is used to designate

the direction taken by the eyes when in a state of minimum innervation or of absolute repose." Nothing is more difficult than to find this position." On further attempting to get his idea of equilibrium, it is found that he defines it to mean the point of rest in any (even) heterophoric conditions, for he says, "the Maddox rod is a good method of determining the position of equilibrium or latent deviation of the eyes," and further on he says, "that in profound narcosis or death the eyes are turned outward."

Dr. Howe does not use the word equilibrium in Vol. I. but defines Muscular balance as "the condition in which, with comfortable binocular vision, accommodation, convergence and torsion bear their normal relations to each other. He sets his definition of balance against Dr. Stevens' Orthophoria of Equilibrium thus:—

Orthophoria.	Muscle Balance. (Eukenesis.)
1. Relates to extrinsic muscles only.	1. Relates to extrinsic and intrinsic muscles.
2. Visual lines tend to parallelism.	2. Visual lines parallel or converging.
3. Binocular vision may or may not exist.	3. Binocular vision must exist.
4. Comfort may or may not exist.	4. Comfort is essential.

Other differences might be named in the definitions of the conditions in which the term Balance is used by one, and Equilibrium by the other.

Stevens.	Howe.
1. There is a definite point of departure for a standard.	1. The ever shifting condition requires a standard for each of his numerous subdivisions.
2. There is a common standard for all departures of the normal.	2. The normal can never be found for it is in action in many directions.

If the point of rest and parallelism of Stevens is not adhered to as a standard, we have none from which the abnormal is a departure.

THE STRENGTH OF THE MUSCLES.

Another consideration in the study of the subject of eye strain is that of the strength of the extrinsic muscles (Eukeneses) and their facility of action. Donders and Von Graefe had no idea of their place in the problem of asthenopia.

The turning of the visual gaze from one point to another and the fixation, adjustment or projection of an eye upon an object are of course muscular efforts. Accommodation is a muscular act of the ciliary muscle and convergence is an extra effort of the adductors.

They recognized weakness of these muscles, but attributed the manifestations of it to errors of refraction, which gave the muscles extra labor, from which fatigue and symptoms of pain arose.

When there was no ametropia the asthenopia was termed, by Donders, "false asthenopia," and rather than attribute it to affections of the muscles themselves, a cause was sought in constitutional disturbances.

When it was found that asthenopia occurred in cases of emmetropia or that it continued when they had been made emmetropic by glasses, they still relegated the patient to rest, constitutional treatment or change of occupation which gave them less activity in the use of their eyes.

As late as 1900 when, through the writings of Noyes, the profession had come to believe in Muscular Asthenopia and to recognize, in theory at least, that when there was weakness of the extrinsic muscles, they should be treated by discipline to strengthen them—the directions for doing this were still of the most vague and unsystematic sort.

Dr. Noyes developed a practical method for disciplining these muscles, and showed much patience in this particular necessity as he found it.

Landolt saw the weakness of muscles and compared it to the condition of an equestrian, out of practice and liable to be thrown from his horse and recommended discipline of leg convergence, that he might be able to stick to his animal.

But for the weak convergence of the recti, he merely suggested discipline without exercising his usual acumen in inventing apparatus, as he did for diagnosing.

All along, for a couple of decades, the opinions of writers, pro and con, in regard to the question, whether there was such a thing as Muscular Asthenopia, and whether the discipline of the muscles was of any avail, were freely given.

"Insufficiency" was regarded a weakness, yet remedies for weakness were not used to strengthen. Dr. Dyer, as we have seen, was the first to institute measures of relief according to the laws of physical culture. His system was empirically applied and consisted in disciplining the ciliary as well as the recti in convergence, and to so change the relation between the two that there was a new environment, or a new order of things—he did not know what or how—but discipline was instituted for the muscles, for the first time in Ophthalmic history.

This system was taken up throughout the land and much was said of it. A few cases were restored, after months of severe trial and watching, and infinite labor and pains.

It was not long before Dr. Noyes developed his ideas in relation to eye strain, and accepting Dr. Stevens' system of appealing to the muscles for diagnosis and treatment free from the accommodative act, he was able to lay before the profession the most clear and well balanced

analyzation of the subject that had yet been published. His writings show infinite pains taken in the subject, with study clinically made and with a mind free from prejudice and dogmatism.

He gave much hope and encouragement to those following out the lines of his procedure. There has not been sufficient attention paid to his emphatic assertions, contrary to the doctrine of Prof. Donders, regarding the relation of Asthenopia and Hypermetropia.

About this time, there were two modes of dealing with that perplexing disease, asthenopia; they were antagonistic to each other, one regarding the muscles as the seat of a high percentage of causes, and attention was directed to its relief through this avenue, the other believing that the whole trouble lay in errors of refraction and that if the muscles were implicated, it was from ametropia.

Dr. Stevens was an active worker in the former method, and he, with Dr. Ranney, was an exponent of tenotomy, a shortening or lengthening of the muscles to obtain equilibrium. They mention orthoptic treatment but relied on surgery to a great extent.

They taught the doctrine of "latent heterophoria"—a condition where, in the ordinary means of examination the full amount of heterophoria is not manifest. Dr. Ranney uses the word "insufficiency" synonymously with heterophoria, and says, "it seems to him to be a congenital defect in most cases, probably all." The "latent insufficiency" of the internal recti he makes manifest, by putting on a pair of prisms, bases in, in spectacles, and has the patient wear them a few days. After the latent becomes manifest, he is enabled to judge of the effect he wants to produce in his tenotomy.

Eyes that show orthophoria or a slight amount of heterophoria before wearing the prisms, will show a considerable amount of heterophoria. This is but in-

dulging the muscles, which, very naturally, take the position that is the easiest for them.

There was a large faction in the profession, who, from natural conservative tendencies—perhaps having tried the radical method of tenotomy, and not having found what was expected, fell back upon the doctrines of Donders and relied upon the correction of ametropia. Some have gone so far as to hold that if relief was not had, it was because they had not skill enough to find the error. All saw a deficiency of strength in the muscles, but held that the cause of such a condition was the uncorrected ametropia.

A few prominent men did not believe in Muscular Asthenopia. But Dr. Noyes re-discovered what Bohn and Rueta promulgated before Donders but which was obscured and set in the background by the brilliancy of the Professor's System of Refraction. The patience and systematic analyzation shown in Dr. Noyes' work; his devising of means to discipline the muscles by a succession of prisms, and the true estimate he made of tenotomy have just begun to be appreciated in the settling of a rational view to be held in the future regarding this wide spread affliction.

Most authors now suggest orthoptic exercise of the muscles, but there is evidently but little faith in its efficacy as practiced by them. This is easily accounted for in the inefficiency and awkwardness of the method. Two authors from whom I have quoted say, "that the prisms from the Test Case are sufficient to carry out this treatment." These prisms are generally ground round edge and are to be held in the hand of the practitioner, or slipped into the trial frame found in the case. When we realize that the manipulation of lenses and the putting on and taking off of prisms from the faces of these patients is a severe ordeal to them, and that the axis of the lens cannot always be right, and that too the strength of the

lens is augmented from 2° to 6° above the index of the lens (varying in amount by the position of the plane of the lens and the strength of it) we can easily see the inaccuracy of the act and the unscientific method of the manipulation. However dextrous the manipulator may be, he will increase the nervousness of the patient and will not get the accurate information that is needed.

The touching of the eye lashes or eyebrows in handling lenses before the eyes of these patients, whether the lenses are single or put in prisms or in batteries with a succession of lenses, is extremely annoying and irritating. These patients are generally nervous and motion is the bane of their existence. The most careful manipulator will often cause nausea and headache or irritability, and either the patient or the surgeon will give it up in disgust. Therefore, the practice of presenting a lens before the the eye for correction—then laying it down and taking up and presenting another, and so on, is entirely wrong. The practice of parting the light and asking the patient to fuse it, and if unable to do so, to present another, is another mistaken manipulation. The information required in getting the duction power of a muscle cannot be obtained in this way.

There is much stress put upon ascertaining the deviation of the muscles from parallelism (Heterophoria) and many tests and trials are made, and repeated on different days, to get the balance. When gotten, the information is of little value towards a solution of the case.

The latest writers have so developed the imbalance theory as to give it a different meaning from that on the basis of heterophoria, which we have had for some time, so that now the definition has become obscure, and almost lost in the development of this theory of equilibrium.

Equilibrium seems now to be an imaginary fulcrum, situated somewhere between the eyes, behind the balls and with some six points extending through the aria of

motion of the eyes, and subject to as great variation as an aeroplane. The whole object to be obtained in the treatment of the disorder of this function is a balance of equilibrium.

If Tenotomy is not resorted to immediately, a process is adopted of changing the load to another muscle, or giving it more or less action by changing the denomination of the lenses or decentering them, or putting the cylinders at a different axis, expecting by this means to counterbalance this imaginary plane to an equilibrium.

When these appeals to the refraction part of the eye prove of no avail in curing the asthenopia, tenotomy is resorted to, or at least that dernier resort is presented to the patient with *emphasis*—a six months' vacation, travel and rest to build up the constitution is recommended.

That the delicate and intricate apparatus of adjustment of the balls should not have troubles of their own, *per se* is contrary to our experience and observation of the human frame. This apparatus in the function of vision is as complicated, and shows as many contingencies in its participation as the focal act, and when we consider the demand upon this organ in the work of our civilization, we must expect and look for trouble in these parts themselves. It is reasonable to expect to find it.

The investigation of the muscular system commenced in the necessities of the internal recti, for the severity of their work in convergence was noticed. By the giving out of the convergence muscles, attention was called to the opposing muscles and the abductors became a study and so the lateral pairs were fully brought into notice, but the verticals and the obliques were yet in the undiscovered physiological world. Those who brought into training the laterals let the verticals go untrained, and whereas the laterals were yoked and "broken" the

verticals received no attention or were handled very differently.

This failure to get results in the vertical muscles may be accounted for in that there was an attempt to treat them with the same denomination of prisms as were used in the cases of the laterals, and not getting response, these muscles were prismsed and sometimes clipped or let alone and considered outside of the general laws of extrinsic muscles.

THE AUTHOR'S FINDINGS.

In a practice of the Specialty of Eye and Ear for over forty years, and adjusting Compound glasses since 1869 in the State of Iowa, I may be pardoned for considering my experience as of some weight and value in the relief of Eye Strain.

With the best facilities to be had during this period, and with as close and skillful attention as I could command, there were many cases that were not relieved to the extent that one, doing such work, would naturally desire.

The subject of the muscles, during this period, was an obscure one but my study of it resulted in the belief that there were a great many suffering from nervous troubles, which could be accounted for in eye deflections, and that if there was a trouble of the extra ocular muscles, which explained the want of its relief by correction of the refraction, gymnastics ought to be of some service in the restoration of the disability.

The directions of the books to accomplish gymnastics were tried, but the labor of it was sufficient to deter one from carrying out the directions, and the patients would drop off before accomplishing what was set out to be done, and, as a natural consequence, the practice of muscular discipline for asthenopic symptoms gradually fell into disuse.

Still believing in the principle, although the practice in it failed, I had batteries etc., made, upon principles, which I thought, from my experience with them, were necessary.

This apparatus was in my hands for seven years before I found the systematic use of it in these cases of Functional troubles. Two or three cases fell into my hands in 1896, which had been glassed and carefully treated according to the doctrine of Refraction and not relieved. I commenced, and carried out empirically the treatment, which is essentially that which I have followed ever since with gratifying results. I have deduced and worked upon the following principles.

1st. The diseases presented, formerly designated asthenopia and now termed eye strain, are *disordered functions* and consist in weakness or insufficiency of the eye muscles, intrinsic and extrinsic, and the chief symptom is asthenopia.

2nd. This weakness is found in cases of emmetropia or orthophoria as well as in ametropia or heterophoria; caused from overwork of the eyes, or from the general need of tone, refractive error or the absence of proper nourishment by aliment for assimilation.

3rd. When the refraction is hypermetropic, unless there is an extra compensation of muscular strength in the ciliary, focusing becomes a burden; or when there is heterophoria, a like compensation is wanting, the excursion of the extrinsic adjustment is lengthened and made difficult, and the eye balls lag and mal-position is the consequence. In either case fatigue is experienced and, unless there is great apathy asthenopia sets in.

4th. This weakness may be from obstruction in the eye tissues; it may be from an imperfect conducting quality of the nerves supplying the muscles; it may be from a want of nervous force; lastly, it may be in a defect-

ive brain (central). All of these causes of weakness may be considered as weak innervation.

5th. The indications are (if this theory be true) to overcome the weakness by administering those aids which strengthen muscles and innervate them.

6th. The principal aid in strengthening muscles is gymnastics. The effect gained by this means remedies the various pathological conditions mentioned, and makes the muscles effective. All the extrinsic muscles are equally amenable to this appeal, when a proper variation is made under the general laws governing all of them.

NATURE-AIDS.

In view of the conditions which we pronounce departures from the normal or from the standards we set up, the most rational conception seems to be that nature strives to mend or correct these defects that interfere with the action for which eyes are made, or re-constructs or fits them for the work which their environment has put upon them, and it is the business of the Doctor to aid Nature in accomplishing this.

Science tells us that in the progress of the species, the orbits have been brought around toward the median line from 90° , found in the fishes and most of the birds, to man whose orbits diverge but 24° or 30° , and we know that the eyeballs can be maintained at parallelism within these diverging sockets, and not only that, but under the necessity of convergence, man, to do his tasks, is enabled to converge 50° inside the median line.

From this history of the organ of sight in the past ages and the conditions we find in our study of the human eye, we can draw a lesson.

It is safe to regard the functions of the organ with which we are dealing, as well as those of many others of the human system, as under our control under the laws

of development, and to note that changes are continually going on for better or for worse; that man's dominion on the earth shows a wonderful power in directing and fashioning the species, and in regulating and improving the functions and moulding the good qualities in his own race, or in animals over which he has control.

Then it is reasonable, in the present application, to remove those things which prevent good action in this function; to administer to the weakness, and tone up the innervation, and use any other means that will strengthen, giving Nature a chance to right up all imbalances if these interfere with proper functioning.

But, if after this attention, the eye balls do not take the position, which is found necessary, it may be advisable to shorten or lengthen muscles, so that there may be less expenditure of nerve force in accomplishing the excursion needed for adjustment, but not before the orthoptic treatment has been well tried.

There has *not* been a proper recognition of this condition and *very poor* treatment of it. If the theory, that Nature is bending her forces to the accomplishment of the demands of environment is true, there will be but few cases for such interference, for she is wonderful in the adaptation of means to ends. My experience is, that surgical interference is not required in exophoria at all, if there is vision or even perception of light in the deviating eye. I have operated by advancement, on these cases, for years.

CLASSIFICATION BY POSITION.

HETEROPHORIA.

Heterophoria is most likely to be one of the consequences of weakness or of pathological conditions, and *not* heterophoria the cause of asthenopia. In Heterophoria the excursions of the eye balls to prevent dip-

lophia for distance, is greater than in Orthophoria. This requires more expenditure of nerve force, and weariness is apt to show itself, and perhaps pain. The function act starts with a deficit, as Donders said of Hypermetropia. If the nerve supply is sufficient, the work *not* protracted beyond limit of capacity, or the heterophoria *not* too great, there is but little inconvenience.

EXOPHORIA.

Hypermetropia causes weakness of the ciliary from overwork, and we have accommodative asthenopia. This condition is properly helped by convex glasses, but the former stimulus given to convergence by the excessive accommodation, is removed by the glass, and, unless there was formerly excessive convergence, the internal recti are now relieved of this stimulus and they are thrown into an independent condition. This develops weakness and muscular asthenopia often arises from it, and exophoria is developed. This course of reasoning is properly applied to the insufficiency of the internal recti and to the causes of exophoria in hypermetropia, of which the writer has found a large number. Where there was but little weakness at the beginning, this brought on exophoria and for every degree of divergence, there was additional necessity for effort and nervous energy to cover the gap, that was continually widening as exophoria was developed, and until the patient could learn to suppress the image of the deviating eye, there was continual labor and pain. Asthenopia, however, subsides as the effort to fuse the images is given up, but this is at a great cost of useful vision to that ball and to the patient's ability to avoid danger to his person, and I may add—to the looks of his face.

It is not yet established that all eyes should be made emmetropic by glasses. Besides, the interference convex glasses have with convergence, it is quite certain

that hypermetropia, if not great, is a better condition for a healthy development of the eye in children than emmetropia.

ESOPHORIA.

In esophoria the external recti have the load in respect to distant vision, but if of moderate degree, say 8° or less, when there is abduction sufficient, there is an advantage in the act of convergence—that is, if there be no undue action or spasm of the internal recti. The ball is in or near the position for near vision, without the necessity of the convergence act. Nevertheless, in these esophoric cases there is weakness of adduction, with as high degree of esophoria as 8° , and to cure the asthenopia, adduction has been given, but abduction should also be attended to before discharging the case. The esophoria may increase, but long before adduction has been brought to the standard, the asthenopia will have vanished. Often the esophoria increases in exercise of the adductors even as high as 14° and the patient is discharged in this condition, but in a short time, the lateral muscles will be found to be towards orthophoria. If the abductors are strong, the needful movement is easily made to parallelism.

HYPERPHORIA.

The verticals have been the last of the muscles to be recognized as participating in this wide spread affliction. Although Drs. Stevens and Noyes found hyperphoria and, with it, severe trouble—the remedy was to put prisms, with base up or down, into spectacles. These of course relieved for a time, but soon a greater degree of hyperphoria developed and stronger prisms were prescribed, until the indulged muscles allowed the eye to hide under the lid, and a *delicate, uncommon and skillful* graduated tenotomy is consented to, by the patient.

Having discovered the right denomination of lenses and the proper interval between them, I found that orthoptic treatment was as efficacious on one pair as any other pair, and that they all responded equally well and were equally amenable to the general laws of eye muscles.

CYCLOTHORAX.

The oblique muscles have command of the torsion or wheel motions of the eye. The normal position of rest—the vertical axis of the upper end—is said to be about three degrees outward of the vertical line. “Every motion of an eye from the primary to an oblique position is accompanied by torsion as an essential component of the motion.” *Maddox*. This was recognized by Donders, Helmholtz and developed in Lystings’ Law.

In oblique astigmatism the oblique muscles are called upon to correct it, so that the axis of vision may correspond to the vertical and horizontal lines, of which print and objects generally are made up.

To Dr. Savage, we owe the discovery of the “Inefficiency of the oblique muscles.” and a method of clearly and easily detecting it. I have not had satisfactory results in treating it with cylinders, as he recommends. We, of course, correct astigmatism that may cause the overwork of the oblique muscles, and treat for strengthening the obliques the same as we do the verticals. It often disappears, without direct appeal, in treating the recti.

My observation and experience in treating these cases of eye strain is, that it may come in the emmetropic and orthophoric eye as frequently as in the ametropic or heterophoric eye, and weakness of the ciliary muscle or of the external muscles may come as well in one as in the other, accommodation becoming difficult and con-

vergence painful; soreness, nervousness and inability for protracted work are present, but accommodation may show normality and there be no, or very little, deviation of the muscles. The inclination is to favor the muscle, and the common idea is to rest and avoid use when they hurt, and there is developed, "insufficiency" and in many cases exophoria. When a phoria is developed, it adds labor to the muscle of adjustment; the excursion of the eyeball to accomplish a fixation becomes, more and more, an extra task. That the trouble should be supposed to be in the deflections or the heterophoria, seems to me a great mistake. For the classification of these cases, we will group them differently.

CLASSIFICATION BY PATHOLOGICAL CONDITIONS.

VASCULARITY.

Prof. Donders, in speaking of the fatigue of the muscles, mentions as the result of the performance of labor, "the products of metamorphosis of matter in the muscle tissue."

This physiological condition may be the explanation of a pathological state, which we find in a group of cases with symptoms of eye strain. This group, which is characterized by a hyperemic condition, is of wide extent. The patient may have this hyperemia for years without the characteristic of inflammation, (the sticking together of the lids in the morning) which shows the dividing line between hyperemia and inflammation. With some, there is a tearing and with others a dry hot sensation. There is a general vascularity inside (ophthalmoscopically) and out. In the advanced or chronic stage, styes and pterygium may be developed. The patient soon learns to school himself to avoid motion of the eye balls because of the pain in friction of the balls and lids; the eye takes on a dull sunken and soggy appearance,

and the individual mopes and subdues all impulses to animation, and looks disconsolate and spiritless. Every act of fixation blurs and most sufferers pass the fingers or knuckles across the lids every few minutes, they take off their glasses to press, or squeeze the balls by strong closing of the lids, which press upon the balls and take off the tension of the muscles for a moment and perhaps accelerate the circulation to absorption. They school themselves not to fix upon an object, and allow motions and other things to happen before their eyes without notice, and in walking on the street avoid observation. For this purpose, they wear black glasses and attribute their pain to intolerance of light. These cases are not characterized by great nervousness, excitableness or sleeplessness.

I believe they may be classified as reflection of eye strain on the Vaso-Motor System. It is remarkable how quickly these cases respond to proper treatment by gymnastics.

NEURALGIA AND NEURASTHENIA.

Another group of asthenopic symptoms is found when the patient suffers through reflex on the fifth nerve system. Ranney in "Nervous Diseases" says, "The causes of neuralgia may be classified—(1) The predisposing—(2) modifying—(3) exciting," and says under the first, "I believe, from somewhat extended research, into the probable factors which tend to induce the neuropathic tendency, that the eye strain and abnormal eye tension are, perhaps, more closely related to the obscure and imperfectly understood conditions than any other factors, which have yet been observed."

"As a rule, it may be stated that neuralgias are seldom dependent upon pathological changes. In a few exceptional cases, however, the nerves and the nerve centers may reveal, in a variety of ways, the existence of a mor-

bid state." "We are forced to admit that the pathology of neuralgia is not yet understood."

"All the later observations of Dr. Stevens and myself," he says, "go to show that neuralgic attacks are curable in a large proportion of cases, when treated by the relief of eye strain".... "Like other purely functional neurosis, the detection of the cause and the removal of the irritation (generally of a reflex type) results in the permanent benefit of the patient, and a more or less complete cessation of the attacks.

Dr. Joseph Collins (J. A. M. A. Jan'y '09) says, "Nervous Diseases are looked upon as mysterious in their manifestations, incomprehensible in their display, unamenable to treatment and therefore unworthy of profound effort at interpretation." Functional or Organic? There are diseases in which no characteristic anatomic alterations are found after death, and yet, we believe these to be organic diseases. Among these are paralysis agitans, grave myasthenia and hyperthyroidism. There are other diseases commonly spoken of as diseases of degeneracy or deviation such as tic, hysteria, idiopathic epilepsy and psychosthenia, possibly migraine, which are not likely to be found associated with anatomic alteration.

Dr. Collins further says, "There seems to be something about functional nervous diseases, which is decidedly repellant to many members of our guild.... Another feature of his attitude is the belief, feeling or assumption, that these diseases are not real, that they are more or less assumed, that they are manifestations of weakness of contumacy, that they are a sort of splotch on the escutcheon of health and of moral dignity, that they are evidences of stubborn perverseness, which excite a mingling of sympathy and contempt, that they are products of disordered imagination."

"This is a distinct sequel of the view which looked on functional nervous diseases as manifestations of demon-

iacal possession, and it is much less prevalent than it was a generation ago."

It is not to be wondered at that nervous diseases are so little understood and that their phenomena are a mystery. When we remember what the system of refraction has done in the last fifty years, in relieving headache, we marvel that even in our time, books have been written on headache, without a mention of Eye strain as a cause. Dr. David Webster saved the credit of Dr. J. Leonard Corning's work (1894) on "Headache and Neuralgia," in an appendix on eye strain. Francis E. Anstie on "Neuralgia" (1872) has not a word to say about the part that eye troubles have in producing Neuralgia.

Taking the relation of Nervous Disease men, and oculists, they seem to be as far apart as two religions. Although they graduate at the same schools and study the human system together, they have but little consultation over those diseases in which both should be familiar with each other's experience, if they would master all difficulties.

If one half of what that indefatigable writer, George M. Gould, says in regard to eye strain and the benefits derived from glass fitting be true, and if to this, there can be added the additional cause of *affection of the muscles*, we may truly believe that the specialist of the "Eye" has, within his grasp, the majority of the neuralgic ailments of civilized man.

REFLEXES.

The power of eye strain for making mischief in remote parts by reflex action, is hardly recognized anywhere in general medical literature, yet, there have been reports of surprising relief by the fitting of glasses or the correction of muscular anomalies.

People who had been unable to read a book for twenty years have been restored. Some, who had suffered from migraine for a quarter of a century, have been almost miraculously cured by skillful manipulation about the eye, but the Medical profession is so slow to accept, that the pressure to its recognition will have to come through the education by popular reading, and advertisements among the less educated, rather than through the teaching of those who are the best judges and who are able to test the experiences of their own confreres.

There are people dying in every community from asthenopia as a first cause. Young people, who are driven to desperation by it, sometimes lose command of themselves and go to the bad, because they are unable to work as others do, and often they are drawn to the use of drugs or stimulants.

We are unable to properly judge of criminality or the cause of a suicide, until we inquire about the nervous symptoms and learn the source of that desperation.

Nervous diseases, most of which are not organic, have been classified as Neurasthenia, Hysteria, Chorea, Epilepsy, Psychosis, Insomnia, Brain fag, Migraine, Nervous prostration, Sick headache. There are those in every community, who are counted invalids and who are unable to contribute to the work of society; they are unable to read; to attend church or theater; they often spend half of the day in bed. There are others who are on the go,—travel and work off the surplus vitality by activity, fearing to enter the arena that calls for near work. There are many others, who are assigned to sanitariums—institutions to be amused and to rest—some to asylums, unlabeled. I believe a great percentage of these have asthenopia as a first cause.

The effect of asthenopia is exceedingly variable. One may have only eye symptoms, perhaps only headache of a neuralgic character. It may occur in people who have

an extraordinarily good physique. I have found it in athletes who had good digestion. The direction taken in the reflex contiguous nerves, depends upon the power of resistance these nerves have to repel an attack. In some cases, the Fifth nerve, the ophthalmic branch will succumb to the irritation and neuralgia sets in and migraine develops. Then reflections upon the general nervous system, denominated neurasthenia and symptoms become widely spread, and thus require a more definite classification, familiar to all—named nervousness, hysteria, chorea, nervous prostration, sick headache.

Sometimes the spinal nerves show the direction or course and there is pain at the occiput or base of the brain, and through the cervical vertebrae, and there is tenderness of the spine and numbness of the extremities.

When the pneumo-gastric succumbs to the attack, we have a train of symptoms that may wreck a life. Aphonia may be the only evidence of the weakness, but the heart is often affected; with migraine, the stomach and other digestive organs are often the seat of the most severe symptoms to which the human being is subjected. When this incubus settles upon an individual, life, as witnessed by the observer of it, does not seem worth the living, and were it not that there were intervals of cessation and a clearing away of the clouds, and the sunshine of existence breaking in occasionally, it would seem that an ending would be preferred. Such a life, covering a period of 30 or 40 years—half of it spent in bed with intense suffering, is a marvel of tolerance.

MENTAL.

Yet another tangent for this reflex is upon the mental faculties. Included under this head, some might, with propriety be named, "the perverted senses." These attacks often come suddenly, a wave of confusion, a

sudden blindness, dizziness, an unaccountable fright, insomnia, melancholia, etc.

That the diseases named in this category, and that symptoms difficult to be explained, have their origin in eye strain, is fast being admitted and proved, and that attention to the eyes for their relief is not to be ignored. The relief sometimes comes so quickly, that it has been explained as having some relation to "suggestion"—mind-cure or psycho-therapy.

The many groups of symptoms that have been developed by reflexes generally have the history of eye trouble, but not always. The secondary effect becomes of predominant importance and the eye as the leading factor, is forgotten; the secondary disease becomes the primary one, and the attention of the practitioner is wholly taken up in combatting the symptoms of it without recognizing its genesis.

Not many are now holding out against the assertions, that sometimes chorea, hysteria, epilepsy, etc., are cured by correcting the cause of eye strain.

TREATMENT.

The principal relief that has been reported in cases of reflex eye strain, is that of the correction of refraction and tenotomy of the muscles. Dr. Noyes has more fully recognized the part the extrinsic muscles take in asthenopia, than any other author with whom I am acquainted. With his apparatus, he was enabled to demonstrate the efficacy of orthoptic exercise, but his appliances, although an improvement on those before him, lacked very many essential elements to meet the indications.

My experience, though limited considering the very broad field which I am led to believe is spread by this octopus of human ills, has but partially developed the

possibilities, that I believe exist, in an intelligent and systematic treatment of the motor apparatus.

I find that this apparatus is the seat of the trouble in over half the functional difficulties; and the cause of many other eye troubles; that a very high percentage, if not all of those cases of asthenopia, which are attributed to constitutional causes, are eye affections causing the disturbance of the whole economy. When the muscles receive as much attention as the refraction, it will dispose of as many sufferers in addition, as has the fitting of glasses.

I find that the excessive emphasis put upon the application of glasses in asthenopia, is beyond good judgment and honesty.

There was a time when it was almost impossible to get the consent of the parent for the child to wear glasses, but the people are now so well educated that spectacles are sought when complaint is made of the eyes, and if relief is not obtained at the first fitting, a second is tried by the same practitioner, or the patient goes to another, and so much faith is put in glasses that there are many, who have been fitted a dozen times or more.

By following up these cases, it is often found that the variation in the prescriptions is infinitesimal; a quarter dioptre on the medium, one side or the other, or a slight change in the axis of the cylinder. The craze for fitting glasses onto every one, complaining of his eyes and putting on as low as .25 D. spherical, and sometimes a perfectly plain glass has become a menace to good morals and borders on fraud.

For those, who have not learned that the extrinsic muscles have as much to do with asthenopia as errors of refraction, there is some excuse. There are some patients, who think that any glass benefits them, and when once put on, it is difficult to do away with them until the muscles are made right, though they be only .25 D. or even plain glasses, but the slight betterment

comes so far short of the actual benefit they might have, that it seems to those, who know the situation, that it is a farce.

By experience, I have come to the conclusion that in young persons there is no need of a spherical of 1 D. or under, or a cylindrical of .50 D. when that cylinder stands at 90° or 180° . It has been said that there is much doubt as to the propriety of putting low powers of convex spherical glasses on children. Since learning that eye strain is so often found in the muscular system, this proposition is the better confirmed. The neutralizing of the hypermetropia is taking off the stimulus in the act of convergence and insufficiency sooner becomes manifest. If the cylinder that corrects, stands obliquely even in low powers, it is often necessary to wear it, because objects, letters and other things are made up mostly of vertical and horizontal lines. Nearly all cases which I have treated for asthenopia, when 1 D. or under, voluntarily took off their glasses. I have had a large number of cases, who had a refraction of +1.25 D. or +1.50 D. who have gone without their glasses for months and some for years, and some of them are very close to the age of forty years.

The facts are that asthenopia is seated in the extrinsic muscles as frequently as in the ciliary, but there are a few who have pure accommodative asthenopia, and these are relieved by correcting the refraction. Most accommodative asthenopia is associated with muscular asthenopia. The treatment of the external muscles innervates the ciliary for it is supplied by the same nerve. The differentiation of Accommodative and Muscular Asthenopia, by the symptoms, is very difficult.

A prominent symptom of muscular trouble is the victims' horror of motion; it is the bane of their existence, and they soon assume a stoical manner and deny themselves amusements that involve motion before their

eyes, or riding which gives apparent motion to fixed objects. These persons suffer most at sea, for sailing is but the two relations acting together.

The story of asthenopia for fifty years, as told in these pages, is a tale of general neglect, or of a long delayed recognition of the participation of the muscular system of the eye, in the wide spread affection of asthenopia; that the inefficient methods of the few, who have found that the muscles have such a bearing, that the work of those few has been set aside and the treatment they instituted, ignored, and that the teachings of many authors has either been, that there is no such thing as "muscular asthenopia" or that all asthenopia can be cured by correcting the ametropia, and on the other hand, that there has been much teaching of the doctrine, that muscular troubles are an imbalance or want of equilibrium, and do not lie in the pathological weakness of these muscles — in view of all of this, I recommend a *new* method and a *new* view of the condition.

In consideration of the fact, that the method instituted under this view, has been tried and found entirely efficacious in relieving a large number of persons, who had undergone treatment by the former methods, I ask for it a faithful trial.

THE KRATOMETER.

See Figs. II and III

This instrument has been named from the Greek word *Kratos* meaning strength, and the Latin word *meter*, to measure.

It is intended to carry out in the best manner possible, the principles found necessary in the examination and treatment of the Muscular system of the eyes, on the theory that eye strain, and the chief symptom asthenopia, are situated in the muscles, *intrinsic* and *extrinsic*, and that trouble of the extrinsic constitute at least half of the cases of asthenopia; that this trouble is weakness, from some condition of the tissue of the muscles, or a deficiency of nerve innervation or both together, and that muscular discipline is the chief method of correcting the anomalies. To carry out this method to its best consummation, we find it necessary and most convenient—1st. To furnish in the instrument, the requisite means of diagnosing all the anomalies as well as treating all the abnormal conditions. 2nd. To afford a restful situation for the person while being examined and treated, so that the nervousness so often found may be quieted; to protect the region of the face and eyes, the eye brows and lashes from being touched in manipulation of lenses, which often occurs in the usual methods, causing nervousness, sickness and headache. 3d. To manipulate the lenses smoothly and with facility, at right axis and with uniform intervals; to be able to pass the requisite number of lenses at a sitting to effect the purpose, with comfort to the patient and with as little labor as possible.

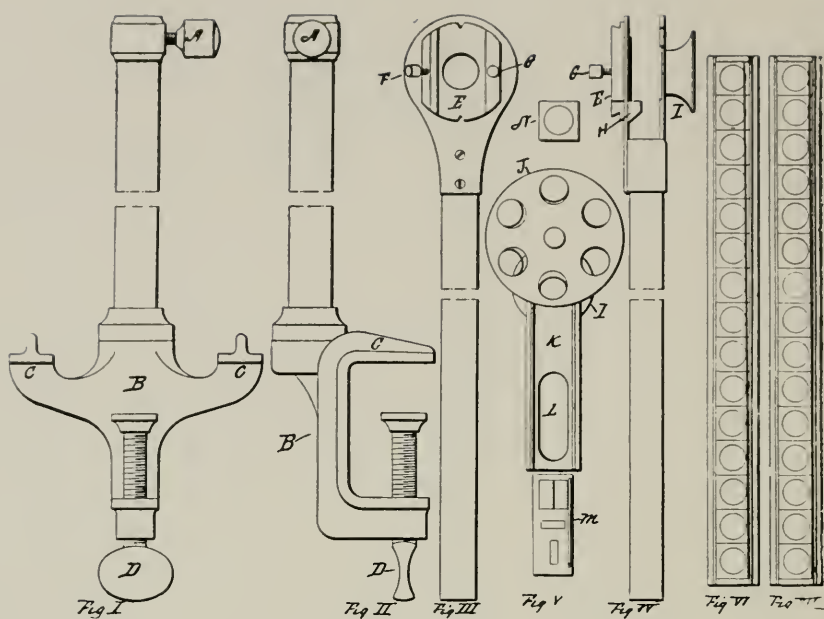


Fig 11.

HAZEN'S KRATOMETER

*For Gymnastic Treatment of the Extrinsic Muscles
of the Eyes*

E. H. HAZEN, M. D., Ophthalmologist
A. W. HAZEN, Optician



Figs. I and II—Stand.

Figs. III and IV—Head with Stem.

Fig. V—Phorometer Slide.

Figs. VI and VII—Batteries.

A—Set Screw.

B—Clamp.

C—Fingers of Clamp.

D—Clamp Screw.

E—Battery Guide.

F—Set Screw.

G—Set Screw.

H—Lens Rest.

I—Eye Cup.

J—Lens Disk.

K—Phorometer Slide.

L—Pupillary Aperture.

M—Maddox Plate.

N—Red Glass.

ITS APPLICATION.

DIAGNOSIS.

The instrument is made so that, when screwed to a table, the vertical and horizontal lines are correct. The very accurate adjustment necessitating a level to the instrument, is superfluous. A general attention to the table used, with a plum line and square is all that is necessary. The height of the instrument should be adjusted by the height of the stool on which the patient is to be seated, and the height of the head piece in the instrument, which is fastened by a clamp screw. The head should be in the primary position and the P. D. arranged. The apertures in the cups through which the patient looks, are about a half inch in diameter, this size being found large enough to give sufficient field, and small enough to prevent the patient from deflecting the head to correct an hyperphoria, instead of by action of the muscle.

The two batteries contain 15 lenses each, one (the units) has an interval of one degree, rising from 1° to 15° bases on the side, so it can be used, base in or out. The other battery (fractional) has intervals of $1-4^{\circ}$ with base up or down and rises to $3\ 3-4^{\circ}$.

THE PHORIA.

The phoria or balance is tested by use of the Maddox Rod and Maddox double prism, which are in one plate and are adjusted before the R. E. and a red glass is near in the same slide to throw over the L. E. as occasion requires.

LATERAL MUSCLES.

To get the balance of the Lateral muscles, the horizontal rod is placed over the R. aperture—if the streak of light which it produces, is through the light, it is

orthophoria, if it is on the right, we have esophoria—if on the left, it is exophoria. By carrying the units battery up, entering the least degree first (base out) until the streak is through the light, the prism that brings it into this position, gives the amount of esophoria; if the battery is carried down (base in) the amount required to bring the streak into the light, gives the amount of exophoria.

VERTICALS.

The examination of the verticals is made with the Maddox Rod placed vertically over the R. E., which gives the streak horizontally. If the streak is below the light, we have R. hyperphoria; if above, it is L. hyperphoria. This is measured by the 1-4° battery, passing it up or down as required. In examination of the verticals, a small light should be used, or a light behind a small aperture of a half inch in diameter.

OBLIQUE.

To detect Cyclophoria, bring the Maddox double prism over the R. E. and direct the attention to a horizontal line 20 ft. distant. The patient is asked to put his head in position so that the line between the two prisms is midway over the pupil, when he will see the line doubled; on opening the L. E. there will appear a third line between the two; if the line is parallel to the other two we have orthophoria in the L. E.

If the line dips down in the right end, the superior oblique of the left eye is in a state of underaction; if it dips to the left, the inferior oblique is weak. Reverse the Phorometer slide so that we can examine the R. E. with the Maddox prism over the L. E. When the right end of the middle line runs upward the superior oblique of the R. E. is weak; if the left end of the middle line turns upward, the inferior oblique of the R. E. is weak.

CONVERGENCE ROD.

The Kratometer is provided with a Convergence rod for testing accommodation and convergence. It is marked with Centimeters, which conforms to the system of Dioptries and Meter Angles. (Nagel)

The accommodation is measured by use of a small card with print, the standard of Jaeger, which is placed in the carrier of the rod. Note should be made of the centimeter, where the print begins to blur in reading the card. To ascertain the convergence, turn the card over and place it with the line found on it vertically; note the point in centimeters where the line becomes double. Dividing 100 by the number of centimeters in either case, will give you the dioptries of accommodation in one case, and the meter angles of convergence in the other.

READING DISTANCE.

A test at the reading distance, one-third of a meter (33 1-3 cm) is the most practical. At this point, it is well to test the power of convergence, both minus and plus, by carrying the units battery down (base in) to test the converging power in the act of accommodation. If the line still stays single to the end of the battery (15°) place the 10° or 15° lens on "H" with base in—then proceed as before with the units battery. The convergence should be 25° or 30°. I regard this test better than that of Von Graefe, but his should also be made. With the card at one-third of a meter, with the dot line in view, put the 10° square prism on "H" base down; this doubles the card. with the card of the R. E. thrown up above the other. If the line is continuous there is no insufficiency, according to Von Graefe. This, however, will often show up all right for the short time of examination, under the stimulation of accommodation,

but on examination at 20 ft. we often find that patients cannot adduct 5° , showing want of endurance, and that although the line test will show well, yet they may be suffering from asthenopia. These tests unveil a large number of insufficiencies, that are easily cured by muscular discipline. This test is very much neglected in glass fitting. The placing of a convex glass removes, in part, the accommodative stimulus. The internal muscles, having had the habit of converging, commensurate with the accommodation used, now lag in the act of convergence, which is now made independent, and of which there is as much required as before glasses were put on. (Fig. 1)

This is a common trouble in administering to Presbyopia. Although the lenses are right, the muscles are weak and the spectacles are thought to be wrong.

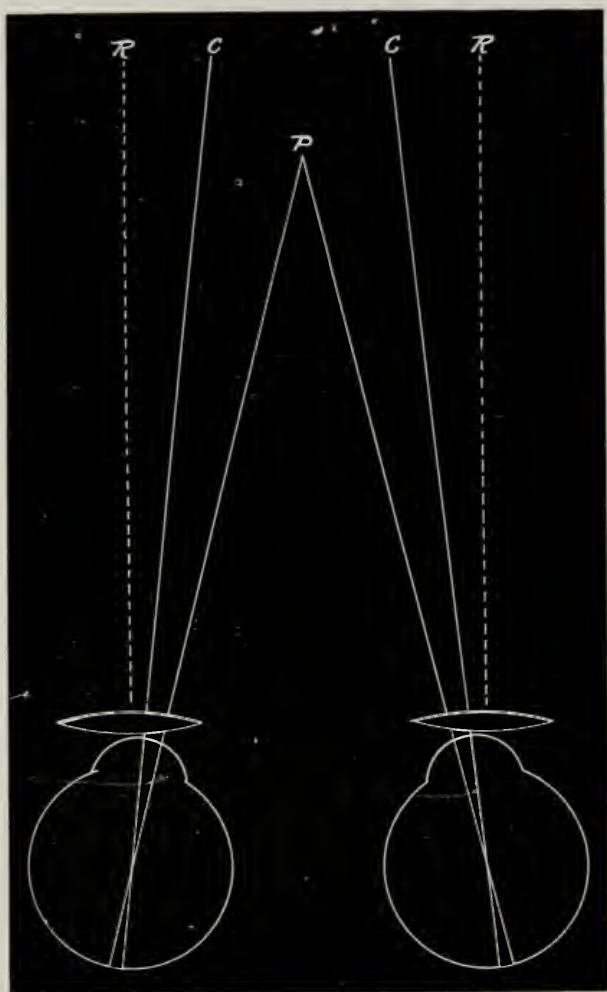


FIG. 1.

(See opposite page for explanation)

Fig. 1. THE EFFECT OF CONVEX LENSES ON CONVERGENCE.

Let R. R. be the parallel lines which the axis of the eyes take on looking at a distance. When the eyes are directed, say to P. (the reading distance) if the eyes are normal, that is, have accommodation and convergence in harmony, convergence accompanies accommodation and both are upon the object, but if for any reason, glasses are put on to aid accommodation to enable persons to see at 3 M. A. the accommodation is aided and there is not the required focal effort made to see at a near point as before; they may see to read with one eye plainly, or for a short time with both eyes, but, as the association between the two functions, accommodation and convergence is broken, the convergence is not stimulated as before, and the visual axes of the eye-balls stand out as represented by the lines C. C. The object then is doubled or indistinct.

When glasses are first put on there is often this weakness and the muscles have to be disciplined by gradual overcoming the new relation or a system of gymnastics must be provided for meeting the condition.

When Presbyopia is gradually met by frequent increase of the convex lens as it developes, the convergence is disciplined by effort of the will and the new relation is met and no great inconvenience is felt, but it is not always thus. Asthenopia may be felt and sometimes using the eyes at a near point, has to be abandoned.

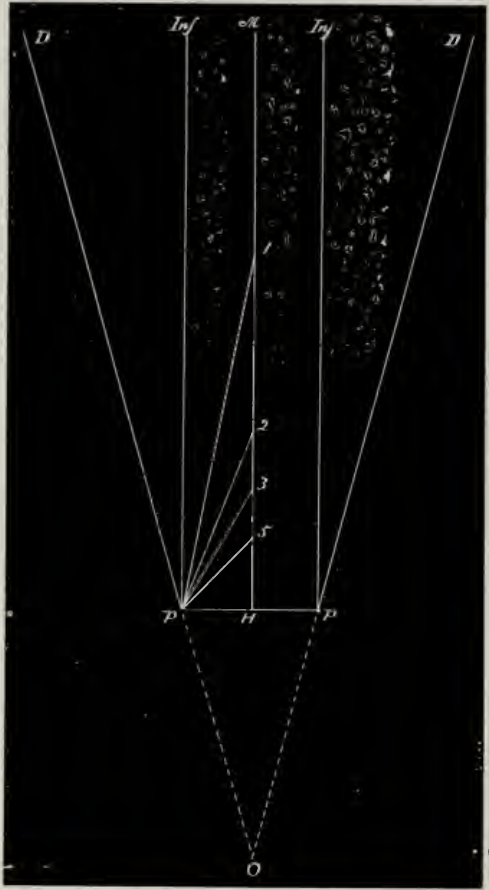


FIG. 2.

(See opposite page for explanation)

Fig. 2. TO DEMONSTRATE NAGEL'S SYSTEM of measuring convergence and its relation to accommodation.

Nagle takes one metre as a unit, called Metre Angle, which corresponds to the Metre Lens in the Dioptric system, which we have adopted in the trial case of which Nagel is the author.

The Metre Angle is the angle formed at one meter distance by the intersection of the visual line with the median line.

In Fig. 2 let the pupillary distance P. P. be the base line; H. the center and M. H. the median line. Inf. will be the direction of the optic axis (visual line) when looking at a distance or "Infinity." The visual lines are then parallel to the median line M. H. Now let the eyes fix upon an object at 1 (one metre). Then the deflection of the axis of each eye to 1 with P. H. forms the angle 1 P. H. and it is the metre angle of deflection or convergence of each eye.

At 2 or 50 C. M. it is 2 M. A.; at 3 it is 1-3 of a metre angle or 3 M. A.; at 5 it is 5. M. A. This system applies to the measurement of accommodation in dioptries and at those points it is represented by the same figures but designed as dioptries. When the measurement is taken on the centimeter scale it is easily reduced to Nagel's notation.

The lines D. D. represent divergence and are measured by the system of Stevens on a distant object and are negative and the angle is formed by carrying it to a point which would be behind the eyes at O.

The condition of the visual axes of many eyes before the glasses are prescribed is represented by the lines D. D.

EXAMINATION.

THE TEST FOR MUSCULAR STRENGTH.

Heretofore, the process for testing the capacity of the muscles, has been to put such prism before the eye as will cause diplopia, and ask the patient to fuse the divided light. This process is contrary to the principles of muscular discipline. The modern method of using dumb bells is to first use light weights, and gradually increase their heft. We would not direct the jumping of a canal to discipline the leg muscles. With this method, so long used, no adequate information of the strength of the recti is obtained.

The appeal to the muscles, by this system, is so radically different, that it changes the whole aspect of the subject of muscular discipline. This fact, with the difference we make in the adaptation of the denomination of the lenses to the particular pair we wish to discipline, leads us to affirm that muscular discipline of the eye muscles has *not* been adequately tried. The quick response to the improved method shows this to be true.

The particular change in method, which we use, is to pass, in succession, the prisms from a low denomination to as high an one as the eyes are able to keep fused, and, when the eyes cannot hold the light singly, we stop, for that last prism designates the strength of that pair of muscles.

THE INTERNAL RECTI.

With the light at 20 ft., commence by turning a 5° prism in the disk over the L. E.; if this is fused, turn on the 10°; if this is also fused, go on until one is turned on that will cause diplopia. When one causes double vision, turn back to the one that can be fused, and then proceed over the R. E. with battery thrusting before it, in the guide (E) the 1°, and carrying it up until the

light parts. This measures the strength of that pair. Care is to be taken that the battery is run smoothly for a hitch or accident, that jars, will cause the eyes to let go. It is better, at the first sitting, to perform this twice.

Another precaution must be kept in mind. These cases have so schooled themselves as not to take notice of objects, moving before them, and they will allow the light to part and one object to pass out of the field without noticing it. On coming to the end of the battery, ask them to take notice, as you quickly jerk up the battery. The eyes are in position to cause two lights to be seen for an instant, if they have fused every one. This will catch their dereliction.

With those whose muscles are sore, the parted light will fly off quickly, and there will be no movement toward fusing again, while with others, the light will sail off slowly, and still others will suddenly see two lights and not see them part. From this behavior, under this test, much can be learned to discipline these muscles.

It is found that very often a patient cannot fuse more than a 5° jump, but will make 12° to 15° in adduction by adding small units, showing the utility of at least a 15° battery for the end of the left, and demonstrating that this process measures, more accurately, the strength of the muscles, than was done by the former method. Then, it may be noted that the muscles will act more uniformly and do better, when they are appealed to by regular intervals, with a slight jump between.

The standard for the strength of the internal recti should be, at least 25° to 35° . It takes 23° to converge to reading distance, but I have seen several cases, who adducted 35° and yet suffered from use of eyes. In these cases, it takes several seconds before the eyes are adjusted, so that quickness and facility of adjustment of the

eyes is a necessity as well as strength. Some of these cases have a history of great discomfort, and have been slower to get well. Other muscles are often involved.

Where there is much exophoria, it is necessary to use the slide lenses accompanying the instrument, putting in a 3° or 5° over left eye with base in, and sometimes the 1° over the R. E. in addition, in the phorometer slide to make the patient see through the eye cups and get within the compass of the instrument. Of course, the denomination of these must be included in the problem.

THE EXTERNAL RECTI.

The strength of these muscles is found by the use of the units' battery over the R. E., carrying it down with the guide (E) with base in—abduction. At the end, the quarter degree battery is carried in horizontally on the lens rest "H," a lens at a time. The lenses being placed, base up, in this battery, adds at the end of the left, a $1-4^{\circ}$ at a time to the unit battery carried in the guide, base in. The standard for these muscles should be at least 5° on the first examination.

THE VERTICAL MUSCLES.

These muscles are examined with the quarter degree battery over the R. E. Infraduction is done by carrying the battery up, and sursumduction by carrying it down.

This is the first instrument provided with a quarter degree battery. In treatment, we give deflection of battery to increase duction.

THE OBLIQUE MUSCLES.

The measurement of the strength of these muscles alone has not been accomplished, except by Steven's Clinoscope, but the strength of those associated with

the Superior and Inferior Recti, I am led to believe can be done with the 1-4° battery, carrying it up or down as required and deflecting it, right or left, to the angle necessary to get into the line of action of the two muscles. The degree of the last fused lens will give the power, that can keep the light fused in this direction.

I have not had sufficient experience with this condition since I conceived the thought to fully elucidate this point.

TREATMENT.

The treatment consists almost entirely of gymnastic exercise. Medicine has been used in its connection for costiveness, and in one or two instances, a nerve tonic.

The refraction is looked after, but, in most cases, they have been in the hands of others and refracted, and as a rule, the glasses are not changed until after the gymnastic treatment has been finished.

In some cases, the lenses worn, are so infinitesimal, that it is recommended to lay them off; as a general rule, we let the former examination stand, and allow the patient to use his own discretion, whether to continue wearing them or not. In the majority of cases, where they are wearing under +1.50s D, with .50 D. cylinder, axis 90° or 180°, they have taken off their glasses voluntarily. In some cases, on first examination, the glasses seemed to be wrong, but exercise of the muscles was instituted, and correction of refraction was put off until the end of treatment, when, after such muscular exercise and discipline, the glasses proved to be all that were needed.

We have never put prisms on in spectacles over any of these muscles since instituting this gymnastic treatment, nor have we seen a case that we would tenotomize, except once, and in that case the vision could not be developed.

Before the discovery of this treatment, I performed tenotomy and, for many years, frequently performed the operation of advancement.

As we have already said, the treatment of the extrinsic muscles is not founded on the phoria, or the position, that the eyes are related to each other, (balance) or that the object in the treatment of them is to correct the departures we set up as standards of position, yet the phoria is one of the concomitants of the disease, and should be watched, and if possible, brought to that position, where there is the least expenditure of force in projection, to do the work of functioning. It is also an index of some indications in the treatment. It leaves the eyes nearer to that ideal which we believe Nature would seek to maintain. We therefore measure the phoria at the beginning of every sitting.

We always discipline the muscles with the object (light) at 20 ft. away, free from the element of accommodation. This we regard as important, as Dr. Stevens' conclusion that equilibrium should be preserved at all points. Von Graefe, he says, was wrong in operating to fit the eye for near work, and throwing it out of balance for distant adjustment. If the eyes are disciplined on the distant point, they are more likely to come into balance, in the end, for all points. Experience shows that in cases, fully disciplined in the infinite distant point, the eyes are fitted for all points. Then, the time in which the eyes are brought to a healthy condition, in this method, is at least 1-5 of the time, given in any report, made by those, who use methods, that combine accommodation and convergence.

We treat the muscles in pairs, and do not know of any use to be made of the knowledge of one muscle of the pair being stronger or weaker than its fellow.

ADDUCTION.

The pair of muscles that do the work of adduction are the muscles that modern civilization yokes to accomplish her ambition and to pile up the fruits of industry. No wonder that the pace man has set for these muscles, should tire, produce aches and at last a break-down.

They are, then, the principal object of our treatment in muscular affections. The standard is 50° and it is often advisable to go to 60° or 70° . This gives a reserve of ability that lasts for years.

With judicious treatment by the Kratometer, 10° to 20° of exophoria have been made orthophoric within a month and amblyopia has been relieved and useful vision restored.

The use of the "slide lenses," as directed in the Examination or Test, is very serviceable and indispensable in high degrees.

The exercise of these muscles should be guided by a good deal of judgment. There are some patients, who have to be urged and taught to throw the will into the converging act; some are very slow and will allow the light to go apart without a bit of evidence of using the will. Others of the nervous, quick ambitious type, will overdo, and if care is not taken, they will undo all the good that the first few treatments almost invariably show. From five to seven lifts are generally all, that should be given at a sitting once a day. If they progress very fast, three lifts are all they should be allowed on this pair.

The progress of exercise is much the same as described in examination, adding 5° at a time, turning the prism, in the disk, onto the L. E. and adding the square lenses over the R. E., which I generally hold between my thumb and finger on the rest "H." I allow a rest of

a few seconds after each lift. The slide lenses can be used if it is desirable to go above 60° .

At the beginning of the treatment, as soon as the light parts, I take away the lenses, but as progress is made, I allow the patient to bring back the parted light, and further on, I urge them to fuse. There is but one degree to correct on the extrinsic of the left in this case.

A valuable use of the square lenses is found to be in climbing to higher degrees of adduction. When a second or third lens in the disk is turned on, the full denomination of the lens has to be corrected on fusing it, and not the difference only between the last two. When not able to correct the last one, instead of turning back to that one which he has fused, by thrusting the 5° square lens over the R. E. on "H" *with base in*, the patient is enabled to fuse—then withdrawing this, it adds 5° more—then putting it back with base out, *that* may be fused—then go on with the battery for the extreme of the lift.

ABDUCTION.

In the discipline of the external recti the units' battery is used over the R. E. and the fractional at the end of the lift. Carry the unit battery down, base in, until diplopia is produced, then go back to the lens that is fused, and thrust in, horizontally, the quarter degree battery, which adds $1-4^{\circ}$; if that is fused, add $1-2^{\circ}$ and so on to 1° . If the pupillary space is made sufficient, there is room for the four lenses. When that is accomplished, we can generally drop the units battery another degree and then proceed as before.

Of all the eye muscles, those of the external recti are the most stubborn, but they will generally yield. More lifts can be made in these muscles, at a sitting, than in any other pair. The standard of Dr. Stevens of 8°

for abduction is to be sought, but 6° is often sufficient, and even 5° will prove to be all that is necessary, if the other muscles are doing their part.

VERTICALS.

INFRADUCTION AND SURSUMDUCTION.

The carrying of the quarter degree (fractional) with the bases of the lenses up over the R. E. or down over the L. E., we term Infraduction, and *vice versa* Sursumduction.

In many of these cases, the slide lenses are serviceable in assisting the eye to see the light through the apertures in the cups. When the L. E. turns up, the base of the prism should be down over that eye or up over the R. E.

Following the rule, that in putting a prism before the eye *as a crutch*, the base should be toward the point to which the eye ought to turn, and in putting it over the fellow eye to help the same eye, it should be reversed, To discipline the eye to action, it is observed the apex is in the direction toward which the eye ought to turn.

With an appeal to the vertical muscles of a quarter degree interval of prism, the muscles respond to gymnastic treatment as well as do the internal recti to that of one degree interval. A very serviceable way to make these muscles respond is, when—for instance Infraduction is the exercise, on going up, when the light parts and the patient cannot fuse, deflect the battery toward the median line at the lower end, to or near to 45° until the lights are fused and ask the patient to hold them, while the battery is returned to 90° . Often another quarter can be added and sometimes a full degree can be climbed at one sitting, and a high degree of hyperphoria can be corrected in one month or less.

CYCLODUCTION.

The treatment for this has been found to be Infraduction and Sursumduction. The cylinder treatment of Dr. Savage, has not proved to be as good, in my hands.

The line of action of the oblique is nearly like that of the verticals. To bring into action the oblique, the treatment under Infraduction and Sursumduction has been found to be effective, and Cyclophoria has disappeared.

RED GLASS.

The Red glass is kept in the slide, as a rule, and is in situation to quickly throw it before the L. E. as occasion requires. In the cases, who have learned to suppress the image, the red glass is often very serviceable. It is sometimes better that the red glass be put over the best visioned eye.

FUSING FACULTY.

I have not met a case that has not the "fusing faculty" unless it was a blind eye. It is sometimes dull but I have attributed the inaction to the presence of Amblyopia, or to the indisposition to call into action the muscles, the patient having acquired the habit of allowing things to happen before his eyes without fixing his gaze upon them. Certain cases, who have had several treatments with about the same indifferent results, when they have been urged to exert their will power and hold the fusing of the lights, have seemed to awaken to a new idea and have brought this fusion faculty into action.

The successful treatment of these cases is not so simple a matter as one might suppose from reading this description of the process.

The important difference in these cases is not in the imbalance, neither is it in the lifting power of the muscle,

but in the classification of the weakness of the apparatus of this function. It is found in the nervous temperament and constitutional make-up of the individual. Some have nerves like wire, that do not feel anything, when you know that the same amount of irritation would put others to bed. Oculists know this to be true. One man, with ulceration of the cornea, will not acknowledge pain, even when there are ulcerative abrasions, the size of a half pea; another, with a much less dangerous condition, will not leave his bed. So it is in the ocular muscles. A man may have a high degree of hyperphoria, and although he uses both eyes in reading and expends a vast amount of nervous force in adjustment, there is no complaint of pain, and he only drops to sleep in a few minutes.

Another has sufficient nervous vitality to correct an exophoria but irritation is not reflected on systemic nerves. The power of resistance is so effective that the only inconvenience is weariness on near work.

GLASS FITTING CRAZE

The author of this system is well aware of the antagonism he produces, in some quarters, to the extensive craze of fitting lenses for every symptom of discomfort from use of the eyes. He believes that the majority of young people, who are wearing lenses (spherical, cylinders and prisms) have merely had a splint or crutch adjusted, which supports or props up and puts at rest a condition, that should be met by a different method of treatment, and this conviction comes, not from theory but from practical experience and observation. In this category he would make exception in high degrees of Ametropia, which are deformities, and need braces, and of course, also that condition of Presbyopia, which necessitates glasses for all, when the time comes.

After fifteen years' practice of this system, and having practiced the old method twice this length of time, and after making a faithful study of the progress in the management of the Function of Vision, in the hands of his predecessors for half a century; and knowing the claims of the disciples of Donders, regarding refraction; and fully appreciating the great improvement Donders has made, toward the solution in the immense field of disorders of the function of vision—it must be acknowledged that “New Findings” has a narrow margin of *new principles*, but the application of the principles already known, and the findings of new applications, with some variation in appliances, are achievements which are gratifying—especially, when these new applications are responded to quickly and satisfactorily in a large number of cases formerly passed by. They also open new avenues, which the Ophthalmologist has not supposed belonged to his branch; symptoms that are pronounced strange and which go unlabeled and unexplained. While the difference in and additions to the mechanism seem small, the success of the adaption to the end is marvelously great.

Thus we see that “New Findings” is but the adaptation and application of the old and well known principles in physical development; that exercise, discipline and work are the right means for bringing into health and use, any and all functions of the physical organism; that to attain a high degree of perfection in the physical, mental and even the moral system, or attain to the best possibilities of the human functions, *work* and incessant *toil* are necessary, and not *rest*; that to keep these functions in repair, and give them long life, and enable them to reach toward a still higher point of conception, can be done only by continued effort and strenuous activity.

This system of gymnastic treatment of the eye, which I have found practical for fifteen years, and have attemp-

ted to describe in these papers, opens up a successful and effective treatment of certain forms of eyestrain, which have been so easy of management in my own hands and those of others who have tried it, that the success has been a continual surprise and wonder.

We are constantly meeting with cases in whom there has been no suspicion of asthenopic symptoms, and who have made quick recovery with this exercise. Many cases, classified under the head of nervous and non-organic, have been permanently relieved or greatly benefitted. Not only has it been applied with much quicker and surer results, in those cases of the lateral muscles, already recognized as muscular forms of eye strain, but it has effectively taken hold of those most puzzling cases of the verticals, and, with equal facility, conquered these in which there was formerly no success, and has shown that these muscles belong to the general laws governing orthoptic treatment of eye muscles and are equally susceptible to it.

Again, there is a high percentage of cases, which have been lost to Ophthalmologists, by being relegated to other specialists for constitutional treatment and prolonged rest, and were cut out of the industrial world for a time, or permanently, who have been restored to active usefulness, within a month, by this treatment.

Indeed, I predict that, when due attention is paid to "Muscular Eye Strain," according to the idea of "New Findings," it will be found to occupy as conspicuous a place in Ophthalmology as does that of its twin sister "Refraction."

**EXAMINATION OF EYE MUSCLES
OF 502 CHILDREN**

IN THE

DES MOINES SCHOOLS

From Fifth to Eighth Grade, Age 10 to 12 years.

The pupils were designated by number. The age and whether or nor they were troubled with their eyes was ascertained by questioning; and if any discomfort their symptoms were noted briefly. The vision was taken of each eye singly, and then the balance. The common method of using a prism (square) was used, free from the instrument to see what prism could be corrected in adduction. The test was then made by the Maddox rod for lateral and then vertical deviation. The number of inches was noticed on the cross-bar as suggested by Maddox, and the deviation was measured, also by the prism. Care was taken to have the aperture through which the candle shone, at twenty feet distant, but half an inch in diameter to get the hyperphoria, and a $1-4^{\circ}$ was noted. There was no consonance between the number of inches on the cross-bar, either lateral or vertical, to what was found by the prism. It sometimes differed widely. Fifty-six of the cases had hyperphoria of this amount but in my tables I do not use this amount in casting up the percentage of hyperphoria, so that I might conform to the reports of other observers. These tests were also made by the Maddox double prism for heterophoria, at 16 inches distance; the double prism also for cyclophoria; then Von Graefe's test at 16 inches with base down looking at a dot with line drawn vertically through it. In high degrees of heterophoria, the red glass is used over one eye. The duction power: adduction, abduction and sursumduction—carrying the battery over the right eye was then taken, one right after the other.

Of the 502 examined, there were those with one blind eye, strabismus, and dummies, making 12 cases deducted

from 502, which leaves 490 from which I compute my statistics. Of these, half were boys and half girls. Two hundred and forty one, 49 per cent of the number claimed they had no trouble with their eyes, and 249 had more or less "hurt"—51 per cent. Twenty-seven more said at first they had no trouble, but on questioning them further admitted that they had had headache, but did not attribute the symptoms to any connection with their eyes. Of the two hundred and forty nine cases, 50 per cent had symptoms of headache—forehead, temples and back of head—eye ache, dizziness, watering, blurring, double vision, smarting and hurting on use of eyes. Of the four hundred and ninety, sixty had vision below standard. A few of these had vision in one eye 20/xx. There were 28 wearing glasses; 25 had worn glasses but had discarded them.

The refraction was not corrected before the examination of the muscles was made. The balance and strength of the muscles was the object, aside from the cause. The tables herewith will give further results of this examination.

TABLE NO. 1 SHOWING THE—PHORIA.

ESOPHORIA		EXOPHORIA		HYPERPHORIA		RECAPITULATION	
DEG.	NO.	DEG.	NO.	DEG.	NO.	LATERAL	
$\frac{1}{2}$	67	$\frac{1}{2}$	37	$\frac{1}{2}$	41	Orthophoria	96 19%
1	68	1	42	$\frac{3}{4}$	21	Esophoria	288 59%
2	42	2	12	1	12	Exophoria	106 22%
3	37	3	6	$1\frac{1}{4}$	5		
4	30	4	5	$1\frac{1}{2}$	5		490 100%
5	11	5	1	$1\frac{3}{4}$	2	VERTICAL	
6	9	6	1	2	1	Orthophoria	343 70%
7	3	8	1	$2\frac{1}{4}$	2	$\frac{1}{4}$ Hyper'a	56 11%
8	6	9	1	3	1		399
9	3	12	1	$3\frac{1}{4}$	1	$\frac{1}{2}$ Hyp & ovr	91 19%
10	1						
11	2		106		91		490 100%
12	4	22%		20%			
13	1						
15	1						
19	1	Orthophoria 96					
20	1	19%					
25	1						
	288						
	59%						

At the risk of repetition of thought, I must, in closing this dissertation on Eye strain, again call special attention to this subject and endeavor to impress its importance and universality, and show up the findings that have been made, which have hitherto been entirely missed, passed over, ignored or repudiated by the profession.

Man's insight into the ailments of humanity is very limited and his knowledge is hampered by his preconceptions, his training, his prejudices and his self interest. He is puffed up with learning and position; he is schooled into doctrines and modes of thought; he casts aside propositions that are not dressed in the fashions of the day; he weighs the movement of confreres in the light of self interest and avariciousness. A new theory, however brilliant and genuine, has to undergo the innuendoes of men, who should be the first to interest themselves in its investigation and promotion.

The history of Asthenopia has its moral and social aspects, which have not been pictured in this book. Men, who have contributed largely to its development, have "suffered the slings and arrows of outrageous fortune," and have been ostracized by their brethren in consequence. But the penalty of radical ideas in this limited field of medicine, is the same as in the other walks of life—martyrdom, in different degrees of severity, is always meted out in proportion to the angle in which it deflects the needle of the staid thought of the times, and hurts in proportion to the size of the angle of current opinion.

The system of the Kratometer, which administers to the muscular cause of eye strain, is new in many respects and differs from that heretofore practiced. It has for its principle basis much that has been previously worked out by others, and the modifications, which it institutes seem to be not very radical, but its adaption to the con-

ditions of this particular form of Asthenopia is astonishing to those who learn to apply it.

There is a certain percentage of weak convergence and hyperemic conditions that responds quickly to the treatment and the result is satisfactory and delightful, but there are in every community those, suffering from the reflex symptoms of eye strain, which produce the secondary symptoms, which are finally taken up as the primary disease, and treated as a distinct disease, and the first cause, the eye strain, is forgotten. These patients first try the oculists or other men who adjust glasses, and most of them have some inkling of the association of the lexttrinsic muscular system (adjustment) of the eye with the refractive part of the function of vision, but as a general thing it is entirely neglected or supposed to be but little involved. The parties, getting but little or no relief, try again and search for the one of highest reputation as a *dernier* resort, and from him they get their ultimatum in his specialty. Unless the Asthenopia is accommodative entirely, they get no satisfaction and gradually come to the conclusion that they are invalids and have some constitutional disease and proceed to the mummyfication of themselves. They may have been advised by their *Dernier*, to quit work for six months to recuperate their health.

This, to many, is too much of a doxology to their hopes and aspirations, and they resolve to consult some Nervous Disease man, for their symptoms are so distressing and unbearable that they are willing to do anything to rid themselves of this incubus. If the tangent, which the reflex has taken, be neuralgic, analgesic remedies are administered; if mental, rest at some Sanitarium with a watchful nurse is recommended; if the pneumogastric nerve plays havoc with the digestive apparatus, a course of diet, baths, electricity and massage are prescribed.

There is a high percentage of these cases that are asthenopic, and have their first cause in Eye strain, and a majority of them are ocular motor, which get different classifications, such as, neurasthenia, nervous prostration, psychosis, brain-fag, nervousness, hysteria, chorea, insomnia, epilepsy. These are classifications of symptoms merely; they are not organic and when the first cause is removed the patient is well.

The professional gap between the Oculist and the Nervous Disease man is a wide one. They have as little interchange of thought or consultation as two denominations in the ecclesiastical world. The human system has a number of tabulated symptoms that arise from the anomalies of the extrinsic muscles, which probably both the Oculist and the Nervous Disease man had opportunity to handle, but neither has put his finger on the cause and does not effect a cure because of this fact. Occasionally some relief has been effected by withdrawing the use of the eyes from labor, and the general health has improved and may be by such process they have been relieved for a short time, but a return to the same labor will bring about like results, for the cause is not removed.

Patients have been under my treatment, who have been glassed by different men from four to fifteen times, and who have also consulted Nervous Disease men, and in some cases both specialists, failing to find a cause for the symptoms described, have attempted to convince the patients that there was no cause for their nervousness and morbid fears, and that there was no occasion for their anxiety that if they would summon their will power, they could throw off their nervousness; or that if they would take their minds off themselves and forget their ailments they would overcome or master the imaginary ills.

These people are real sufferers. It is sometimes psychical; in others abdominal; in others neuralgic; sometimes

attributed to billiousness, dyspepsia, or some constitutional breaking down or want of rest. Whereas all these are the effects of reflex symptoms of eye strain. These patients get no sympathy from their friends. It is often that the manifestation is such that the patient is the only one to whom the phenomena are a reality, and he learns to endure his ills with as much equanimity as he can command.

In the meantime, much suffering abounds in every community, and those who are expected to treat these afflictions, are failing to discover that eye strain is very closely related to many forms of Nervous disorder. When it is once recognized that the reflex effect of Eye strain upon the general nervous system is very severe and wide reaching; when those, who make a specialty of ministering to nervous debility, accept this as the real situation, then they will join hands with the Oculist in investigating this new field, and much good will be accomplished—through their united efforts.

CASES.

Case 1. August, 1896, Miss M. B., Indianola. Student. Age about 20 years. Deficient in constitutional tone. I had corrected refraction but on returning to study had trouble again; pain of a smarting lancinating character. Orthophoric. Adduction 19° ; abduction 8. Having exhausted my knowledge on this case, I sent her to Chicago to Dr. Holmes, who found nothing to do but to give gymnastic exercise on the internal recti. The endeavor to carry out this instruction resulted in the first steps of this treatment. In fifteen treatments I brought the recti to the standard, 50° , and discharged her. She remained free from the trouble and was able to prosecute her studies moderately.

Case 2. November 1896, High school student. Had trouble with eyes since going to kindergarten; remains for hours at a time in a dark room; intolerance of light, especially artificial light; headache about the eyes, could get relief with hot applications. She wore weak cylinders. Vision good, but found it difficult to get clear vision because of blurring or double vision. Esophoria.

2 1-2° .Adduction 20°. Removed glasses. Treatment. Adduction, 23 treatments, when the esophoria was 1 1-2°. Remained in school while treating, and improved from the start. January, 1901, has been free from pain, and only on intemperate use experiences inconvenience. *Has not worn glasses since, and has no trouble whatever.

Case 3. January, 1897. W. G. R. Connected with a newspaper and member of the Legislature. I had fitted him with glasses under a cycloplegia, but he was not relieved. For seven years he had not been able to use his eyes in the evening. In the daytime could use them but two hours, thirty minutes at a time at the most. Eyes smarting and itching and headache. Esophoria, 2°, adduction 5°. In 32 treatments adduction 50°. He used his eyes that winter night and day as any other member of the Legislature. In the winter of 1898, he continued well. He is now the proof-reader in a large establishment.

Case 4. February, 1897. Mrs. J. B. D., age about 30. Had an attack of iritis in right eye three years before, which left eyes weak. Had been under good physicians and two oculists. Vision good. Severe lancinating pains and feelings of eye-balls being drawn back, especially at night. On waking in the morning was obliged to rub eyes. Unable to use eyes with any comfort. Esophoria, 10°, adduction 35°. Treatment, adduction. In 22 treatments was relieved entirely. The winter of 1898 had Lagrippe which seemed to affect eyes somewhat, but did not relapse and remains well. The 10° of esophoria remains in this case.

Case 5. May, 1899. W. H. W. Age about 42. Travelling man. Good constitution and physique; had had neuralgia in and about the eyes for 15 years. Unable to use eyes at near work. Deprived entirely of reading on the cars. Consulted an eminent oculist in Boston, and was wearing a prism prescribed by him, which availed nothing. Examination showed he was emmetropic. Orthophoric. Adduction only 5°. I gave him the Kratometric treatment on adduction daily when in the city, which was broken into sometimes for long intervals and it extended to September, 30 treatments in all. After the fifth treatment he had no more neuralgia, and it never returned. Heterophoria was developed—first exophoria, and then esophoria.

He died from Bright's diseases, August 2, 1904, but had no return of eye trouble.

Case 6. May 25th., 1897. Dr. S., age about 35. Addicted to much reading; for three or four years had been troubled with

ness of eyes on reading; eyes hot and dry, feeling of sand under the lids, which would grow worse if reading was continued, and the letters would dance and become blurred, when in a short time, he would be unable to open his eyes. The swollen condition showed itself under the eyes, like the condition often attributed to disease of kidneys. Emmetropic esophoria, 2° ; adduction 5° ; Kratometric treatment of the adductors resulted in attaining 50° in 25 treatments, when all disagreeable symptoms were removed, and he has had no return of the trouble since. In this case, as in many, the heterophoria increased.

Case 7. Miss S. M., Brooklyn, Iowa. Age 23. Graduated from high school with difficulty, having trouble for about eight years. Tried college work and teaching, but had to give them up, and for two years had hardly been able to read a newspaper the length of a finger. Had been fitted and refitted by different oculists; the last one put on plain glasses. She was in fairly good health. She had nearly all the symptoms of asthenopia given under this head. She was unable to look up, or at any moving object without immediately closing her eyes. Her manner had become stiff and eyes red, dull and without animation. Emmetropic. Orthophoric. Adduction 34° ; abduction 9° ; sursumduction $1-4^{\circ}$. Treatment consisted in the duction of every muscle in the orbit. Adduction attained 65° ; abduction 15° ; sursumduction $3-4^{\circ}$.

By Christmas she was free from pain, attended the theatre without inconvenience and in the next three months read several books without return of symptoms to any great extent. This case puzzled me under my own theories and I could get no satisfaction in the theories of the books. The development of a high standard of strength of the muscles seemed the only treatment indicated. Examined eyes for error of refraction under a cycloplegia (atropia) and found $+ .50$ hypermetropia. Glasses not recommended.

Case 8. October 9th., 1902. J. C. Lohrville, Iowa. Age 14 years. Had been fitted with glasses four years before. The present trouble commenced in January 1902. Pain in the eye-balls. Relief on pressure of the eyes. Exophoria 3° ; adduction 6° ; abduction 8° . In twenty treatments taken in ten days, attained adduction of 60° . Esophoria 10° on conclusion of treatment. She returned home and at once resumed her studies and remains well.

Case 9. December 20th., 1902. Miss N. L. H., teacher. Been troubled five or six years. Constitution good. Been fitted plain

glasses and told to persist in wearing them. Inability to fix eye on object; sensation of drawing eyes backward; nervous, sleepless; eyes watering on use; pain in balls of eyes, shooting through; pain on top of head, back and in shoulders. Relief on pressure of eye balls. Esophoria, 1° ; adduction, 17° ; abduction, 6° . Twenty three treatments. Adducted, 70° . Took set of four prisms to practice at home. Has been free from pain ever since, and is in much better health and spirits.

Case 10. March 24th, 1903. F. W.—Electric lineman, inside work; age about 25 years. Had been under treatment of general practitioner for several months for headache, back and front. For eight weeks it became so severe he had to stop work although it was the busy season. Could not stand on a ladder and, when stooping, black objects came before his eyes. His eyes had that dull look, as if moving the ball was painful. He had no suspicion that his eyes were defective. He was sent to me by his physician to see if there was not some eye affection. Vision $20/xx$. Emmetropic. Exophoria, 1° . No hyperophoria. Adduction, 12° ; abduction, 7° ; sursumduction, $2\ 3-4^{\circ}$. Treatment, adduction. After fifth treatment, there was no more pain in the back of the head. When he reached adduction 30° , he went to work and lost no more time. In fifteen treatments, he reached 50° and, after twenty two treatments, was pronounced cured. He still remains well. He showed esophoria after a few treatments, and quit at $1-2^{\circ}$ of esophoria.

Case 11. Dr. H., Dentist. Age about thirty years. Wore glasses when a boy but not in late years. Had attacks of sudden blindness. Once while playing in an orchestra fell off his chair; was carried home, put to bed and treated for billiousness; there were but few untoward symptoms; some blurring, and a hot feeling of the eyes and pain in temple, but he was generally able to attend to his practice. His physique was extra good.

Emmetropic (manifest) vision $20/xx$ —Orthophoria of all the muscles—adduction 12° to 15° ; abduction 6° . He attained 50° adduction in 6 treatments. In twenty-two treatments he was pronounced cured. The symptoms did not return, and the two subsequent months, he was found to maintain 50° adduction.

Case 12. July 22, 1904. Age 50 years. Architect. Had been fitted by four or five oculists, in this city and Philadelphia. The results of these examinations were about the same, $+1.50$. Very nervous on using eyes; watering of eyes; swelling about eyes; dull drowsy look; dizziness; stomach affected; sickness at and before meals; costiveness; pain in eyeballs, especially in the morning,

also in temples. Fingered and pressed on eyeballs a good deal. About to give up profession. Could not go up onto buildings, and drafting became almost impossible.

My examination of the refraction showed about the same results as found by others. There was a spasm of muscles and examination was not satisfactory.

Orthophoria of both laterals and verticals. Could jump 15° but was slow to adjust when taken away. The exercise caused sickness of the stomach, whenever the highest number he could attain was reached. The light would grow dim but after five or six treatments, the light became clearer and vision on the street improved. In 20 treatments he found that his digestion had greatly improved, and costiveness, for which he had been treated by several physicians, was relieved without medicine. Appetite so much improved that he was apt to overeat.

The esophoria increased under treatment which was mostly adduction, to 14° , but the adduction was uniform in its progress.

At the end of the treatment, there still remained a difficulty in his drafting; the side of the sheet would seem to turn up and form a hollow curve of the sheet. O. D. Astigmatism of $+.50$ was found at an axis of 10° out of the vertical. These glasses, with presbyopic addition, were ample to make him efficient in his severe labors in this very arduous occupation, and the standard has been maintained to the present time without difficulty.

Case 13. August 4th., 1904. Miss J. J. M., age 34. Housework and china painting. Had been fitted under atropia, R. and L. $+1.00$. $+.50$ at 180° V 20/xx. Sleeplessness on using eyes. Car sickness. Pain lancinating in balls. Relief on pressure. Had been troubled for two years, and for one and a half years had given up painting. Esophoria 4° verticals orthophoric. Adduction 23° , abduction 7° . Improved fast in adduction. All the extrinsic muscles were treated and responded quickly. So much improved that she ventured to take in the St. Louis fair and did it without detriment. This case increased in esophoria to 14° but the abduction was 9° notwithstanding, and, in two months, she showed esophoria 8° . She took off her glasses; has painted; kept books, and remains well and, to this time, does not wear glasses.

Case 14. July 24th., 1905. Miss C., age 27. Teacher of drawing. Broke down during study, five years before. Spent two years in Colorado for health and gained 25 pounds. On returning to work lost 20 pounds. A neighboring oculist, on examination under "drops" pronounced, "no glasses needed." She was a slim

nervous organization full of ambition. No car sickness but going to church always gave headache. Pain back of head, running down into spine. Relief very quick. No more headache after five treatments. Although attaining to 50° of adduction soon, exercise continued because slow and want of facility of adjustment. Finished in 27 treatments. She gained in weight before end of treatment, and afterwards engaged in active pursuits without relapse.

Case 15. February 6th., 1906. Mr. B. A. C., neighboring city. Age 29. Pharmacist. Has been fitted with glasses by five oculists, one in Chicago, the others in other cities. Tenotomy, three times. Eyes red and angry. Riding or attending theater used him up. Pain, smarting, sticking of eyelids; back of head, temples and shoulders, on pressure of hand, would get temporary relief. Had taken strychnia, and had some prism exercise. Esophoria and some hyperphoria. Adduction 32° , abduction $31-2^{\circ}$. The adjustments were very slow.

Gave general discipline of all the muscles. With 28 treatments was entirely relieved. Have no report after two months, but up to that time was all that could be desired.

Case 16. March 29th., 1905. Miss B. H., miniature painter. Had spent several years in France and Holland under the best teachers for her art, and opened a studio in New York City. Became nervous and unable to work—had not thought of the cause being in the eyes at first. But eyeballs became swollen; blurring; pain in the eyeballs, head, temples, extending down spine. Consulted three oculists in New York City. The duction in all pairs of muscles was unusually good. Adduction 40° abduction 5° . Infra- and sursumduction, $2\ 1-2^{\circ}$. In two weeks, duction of all muscles was up to standard. Able to read without headache. In one month discharged. Returned to her profession, opened a studio in Chicago, and took the prize for miniature painting at an exhibition in Philadelphia.

Case 17. March 11th., 1906. Canadian. Age about 40 years, Exophoria, 18° . Hyperphoria 18° , L. E. Emmetropia. This case was remarkable for lack of pain. She was wearing 4° , base in over one eye and 4° , base up over the other eye. She could not get along without these on the street, and required $+1.25$ D. for near work in addition.

With these prisms, she could adduct 13 and infraduct, $2\ 1-4^{\circ}$.

In two weeks the lateral prism was taken off and the vertical changed to 2° . In less than two weeks more she became ortho-

phoric in the lateral and adducted 50° and the verticals 1 1-2° with a 2° prism. In one month was enabled to go without prisms indoors. At the end of six weeks, she wore a prism of 2° for hyperphoria and a blank for the laterals.

She was unable to continue the office treatment longer. This case was treated by gymnastic exercise alone. no medicine or operation. During the whole treatment, she read and wrote many hours a day. I have not the least doubt but the vertical muscles could have been brought to Orthophoria in another two weeks' treatment and then an occasional attention over a period of three months to keep them balanced, but she came from a distance and was unable to remain longer.

Case 18. May 31st., 1907. Miss J. D., age 28. Had trouble since 10 years of age. Confined to housework, because she could not keep books for her father, who was a grocer. Was treated for two years, and refracted several times by one of the best oculists in the west. Wearing R. E. $+1.50 +.25$ at 180° , L. E. $+1.25 +.25$, 170° V. $20/xx$ $20+xxx$. Carried head to left to avoid diplopia; intense pain if turned to right. Pain in temples, forehead and back of balls and occipit.

Exophoria 10° ; adduction 9° ; verticals normal. Did not change glasses. In ten days, she adducted 50° Headache gone. In one month became orthophoric, and remained so while under observation two months subsequently.

She at once commenced studying, and has been able to fulfil her duties since.

Case 19. June, 1908. J. M. M., age 25. R. R. Mail agente Suddenly broke down on duty and was about to resign. Unable to read on train.

Esophoria, 1° . Verticals normal. Adduction, 15° . For temporary use, gave R. and L. $+1.25$ D. and treated him when at home. In 24 treatments adducted 50° . He has kept at his duty since that time, and does not use glasses, and is entirely free from apprehension about the eyes.

Case 20. June 16th., 1908. E. M. S., age 37. From a neighboring city. Editor and Postmaster. Troubled with eyes for 15 years. Fitted by oculists with R. and L.— 50 at 180° and changed frequently on both sides of the emmetropic line. Exophoria of laterals, verticals normal. He showed no insufficiency at reading point but could not jump 5° adduction for distance, but by presenting 1° increase at a time could go to 17° , slow fusing. Was

told by former oculist that he must give up his work for six months and take a rest.

This man is of good physique, but very nervous and full of forebodings. Whenever he went home, he would tax his eyes severely in an effort to catch up with his work, which had necessarily been neglected. Notwithstanding, he progressed and attained 60° adduction in 26 treatments, and has not only returned to regular duty, but preformed extra duty to catch up back work, and for a short time did not only his own work, but that of his stenographer who went on a vacation. The nervousness has not wholly subsided. unless his inordinate ambition for work is checked, it is to be feared he will break down, but he is going it at full pace at the present time.

Case 21. August 7th., 1908. Wm. McE. Age 44. Traveling salesman. Been troublrd 25 years. Broke down suddenly at school. Has been fitted fifteen times by eminent oculists all over the country, east and west. The variation in formula is remarkably slight. Some added prisms. Has worn glasses for twenty years. Wearing R. and L. $+ .75$ at 180°. Lids droop a little bluish of conjunctiva. Had twitching of lids; learned to keep out of crowds; pain at occipit extending down spine. Has had three attacks of sudden blindness.

Exophoria 2° R, hyperphoria, 1-2°. Adduction, 25°. Infra-duction 1 1-2°. In twenty treatments became orthophoric and duction standard, both lateral and vertical. Reads as much as he wants to—even on cars—no pain and sometimes does away with glasses.

Case 22. September 8th., 1910. Mrs. S., physician's wife, and a musician. Age 32. Been troubled since a girl going to school; sick headache once or twice a week; never went to church, amusements or rode on cars, or went into a crowd, without having to pay the penalty of hours in bed with hot cloths on head. Pain in top and forehead; tender spot occipit and a little to one side.

Fitted 12 years ago in office of one of the best known oculists in the U. S., after going to his office twenty times. Glasses were fitted and changed about a dozen times. She had worn these for 12 years.

There was no particular change in her condition before or since the fitting. Could use her eye for 15 to 20 minutes, but soon had symptoms of headache and sickness. Glasses R. E., $+1.25 +25$. 30°. L. E. $+1.25 V +20/xxx$. Es 3° Verticals orthophoria. Adduction, 7°; abduction 5°; Infraduction, 2°; sursumduction, 1 1-4 .

For a month, the duction stood almost without improvement. Either there was no fusion faculty, or the patient did not, from habit, make any effort to use the muscles. I think it was the latter, for, in less than a week she adducted 40° , improving steadily and in two weeks attained 50° and was discharged with 5° of esophoria. Having broken her glasses about this time, she was compelled to go without them, and finding that she got along as well without them as with them, she has not worn them for two months and thinks she does not need them. Is able to do anything she chooses and no return of pain or discomfort.

I have had three cases of pronounced chorea, two of them resulting satisfactorily, but the third relapsed after two years. One, a boy of 12 years was perfectly cured and has used his eyes uncommonly for one so young. Another, a musician has been free from trouble for four years, although he uses his eyes as a musician, playing in an orchestra in a theater. No medicine used.

OCULAR TRAPEZE.

And Modification of Landolt's Ophthalmodyanometer.

To further facilitate the management of these cases, in diagnoses and treatment, I have devised the "Ocular Trapeze," and a Modification of Landolt's Ophthalmodyanometer.

In the former edition of "New Findings," it was recommended that the light (the best is a small frosted electric bulb) be placed on the left side and a little behind the patient, with the patient behind the Kratometer, at a distance of ten or twelve feet from a looking glass, at least the size of 21 by 27 inches, placed on the wall in front. This method of using the light has proved satisfactory. The light is at hand to turn on and off, and saves considerable expense in appliances, for 20 feet distance, and makes it possible to use a short room and get the proper length.

Then, for examining convergence, the light is in right position, as well as being convenient for making notes in the somewhat darkened room which is the best for this kind of work.

It is necessary to have a black background, and the patient should be free from such surroundings as glass, pictures, or anything that will reflect light and cause confusion with the object light in the looking glass, on which he is to concentrate his gaze.

In order to make the method a still more serviceable one, I have devised this Trapeze, made of 3-8 iron rod in the form of the staple 21 inches inside measurement and long enough to reach from the ceiling to within 5 feet, 7 inches of the floor, and hung by hooks in the end of the rod, into eye hooks, screwed into the ceiling. The rod between the legs of this staple is horizontal and at right angles to the vertical rod.

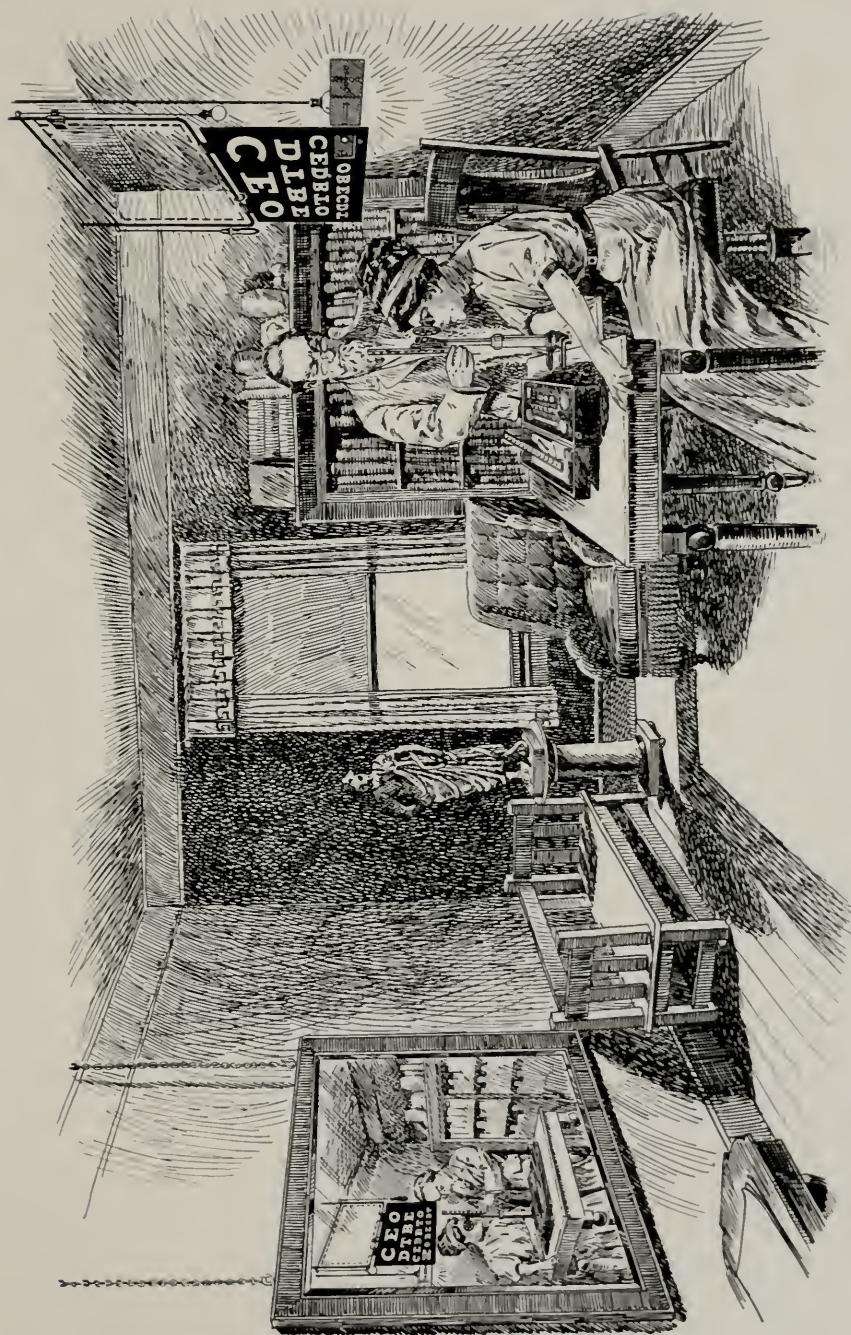


Fig. 3. The Author's Ocular Trapeze—a Method of Examination of the Eye Muscles.

Fifteen inches above this horizontal bar is another bar running across from leg to leg and parallel to the lower one. Into this space between the bars, a piece of tin, painted black, is hung, so as to easily swing in the space described. Two loops of tin are riveted to the sheet, and form hinges around the lower bar and serve to hold in position, when thrown up between the bars, or let down below the lower one. On this trapeze are rings, one at each of the four corners, and one between the two hinges of the lower bar. The two upper rings enable one to thread a string through to give the vertical movement to the light, for testing the vertical muscles; the ring between the hinges on the lower bar to give the horizontal movement for testing the lateral muscles in cases of paralysis of these muscles.

The patient is seated just in front of the trapeze, before a stand, onto which the Kratometer is fastened. The electric light is hung upon the Trapeze, at the left side, behind the patient, and the operator is at his right hand.

In this simple and inexpensive apparatus, the operator has, together with the Kratometer, a complete contrivance by which he can go through all the tests and exercises of the muscles, as well as test vision and detect presence of astigmatism of the muscles, without getting off his stool at the patient's side.

The tests by movement of the light horizontally or vertically placed, which the books describe, to ascertain the muscle paralyzed, are very conveniently performed with this device. The operator has at hand, the other and more modern tests with the Maddox rod, double prism and red glass; he has the light in position for testing convergence and accommodation, and the Von Graefe test for insufficiency; he can hang on this trapeze, the looking glass test type, the lines of astigmatism or the single line to use with the double Maddox prism for test

of Cyclophoria at a distance, or these may be pasted on one side of the tin—better on the side that faces the glass, when it is put up between the two horizontal bars. He also has the test for cyclophoria at the reading distance.

To obtain a small aperture for testing the muscles, particularly the verticals—a half inch hole may be made in the tin plate, in the left lower corner when let down. A smaller one can also be made in this region if thought best. The electric bulb is hung behind this hole.

The electric light may be held in one hand of the operator to illuminate the letters, and the right hand index finger can point out the letter he wishes named, or by reflectors fastened to the trapeze, the whole surface can be properly illuminated.

Glasses may be fitted with this device, and nearly all the tests, regarding the function of vision, may be performed.

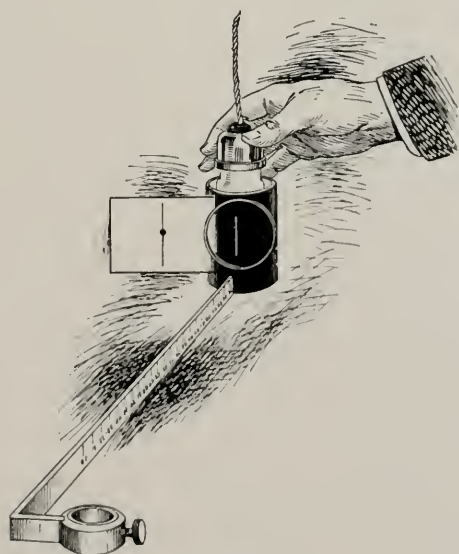


Fig. 4.

Convergence Rod—with Modification of Landolt's Ophthalmo-dyanometer.

OTOLOGY

NEW FINDINGS IN OTOTOLOGY.

OTITIS MEDIA.

A Plea for the More Frequent Use of the Eustachian Catheter.

It is gratifying to one who spans a generation in his profession to see the advances that have been made in the art of surgery, in solving the difficulties that used to be impenetrable to the skill of the surgeons of earlier times. At the time of the Civil War, a person shot in the abdomen was portentous of an early demise, and the surgeon but shook his head when appealed to. Inflammations that started in the right illiac fossa spread to the peritonitis, in which fatality was great. In these days the calvarium is opened with impunity, and the surgeon seeks abscesses in this cavity, as former men sought them in hand or foot. The surgery of Otology is especially brilliant now, and exemplifies the boldness and consummate skill of the surgeon of the day. Lives are today saved by the knowledge of the aurist that would, if the case had occurred in former days, perhaps have been regarded as a mystery, or knowing its pathological condition, the surgeon might yet have been unable to cope with its presentation.

There are yet many who die with purulent inflammations of the ear that produce abscesses of the brain, the sequel of scarlet fever, measles, diphtheria, variola, erysipelas, typhoid fever, pneumonia, diabetes, Bright's disease, bronchial catarrh, tuberculosis, puerperal fever, influenza and lagrippe, unrecognized, or they are allowed to succumb to the secondary condition, without proper attempts to relieve, and this sequel, which we call the real cause of death, is covered up in the diagnosis of the original affection.

The cavity of the tympanum, situated so near to the brain, has its mucous lining extending to the throat through the Eustachian tube, through which so many

diseases incite to its inflammation. This complication becomes the most serious part of the sickness which brought it on. It is said that 99 per cent of cases of infection of the middle ear, are through the Eustachian tube. (Andrews.) These are too often considered lightly by the attending physician, and if the case recovers from the fever, a running ear is thought too slight to be considered, and it is left to be "outgrown."

But while fault may justly be found with general practitioners for regarding too lightly the complications that arise and involve the ear, we think we see the opposite extreme in the hands of the specialist. It is not the desire of the writer to inveigh against the judgment of the specialists who have so cautiously proceeded to so important an operation, and who have saved a few on the extreme limits of dissolution, but rather he would commend the skill and daring that probes the cavities so near to vital parts. The more simple operation of opening the mastoid antrum has become familiar, but he now seeks the accumulated pus that has burrowed to the meninges through the *tegmen tympanum* and around into the sinuses and sometimes buried beneath the Gasserian ganglion and in the region of the torcular Herophili, or in the jugular veins. Nothing daunted, the hand of the surgeon follows it and snatches from Death the victim that has been dragged to the door. The study of brain abscesses caused by middle ear diseases took fresh impetus after the work of Macewen of 1893, and has progressed steadily since. Nevertheless it seems to the writer that there is no necessity for the frequency of these operations at the present day.

Surgical sanction is being asked by some of them to open the antrum mastoides in cases of chronic otitis media, where there is no indication of acute inflammatory exacerbations, and also its performance more frequently in the acute forms.

Twenty years ago there were but few operations on the Mastoid Cells. There are now as many Antrectomy performed in one hospital in New York City in one year, as were performed in all of them in ten years before. A surgeon at a meeting of the Otological Section of the Academy of Medicine, in New York City, Feb-

ruary 13, 1903, asserted that he had examined the reports of three institutions of New York, for ten years, and there were as many operations performed in three weeks, in one of these institutions, as during the ten years mentioned, in the three.

The following tables will give some idea of the increased percentage of operations on the same class of diseases. The operations on the mastoid in the first table, include the mere incisions of abcesses behind the ear (Wilde's), which was a very common operation, whereas the opening of the cells was a very uncommon one.

The first table is taken from Dr. Roosa's book on "The Diseases of the Ear," fourth edition (1891).

The following table is compiled from late reports:

	Mat'd				
	CASES	YRS.	AFF.	WILDS	INCISION
Manhattan Eye and Ear Hospital	14,720	17	110	105	and Mastoid
Brooklyn Eye and Ear Hospital	18,366	18	91	126	
N. Y. Opth. and Aural Institute	14,634	17	112	108	
Mass. Charitable Eye and Ear	9,533	3	62	30	(estimated)
Newark Chart'Eye and Ear Inf.	3,021	3	22	15	
Illinois Eye and Ear Inf.	2,464	4	8	16	
N. Y. Charity Hospital	20	1	1	1	1
Dr. Roosa's practice	5,797	22	59	42	
Total	68,555			443	

The following is compiled from late reports:

HOSP TAL	CASES	YR	MASD'	AFF.	MAS'D	OP'N
Royal Ear Clinic, Halle	2,425	1				129
Royal Poly Clinic, Munich	2,831					44
N. Y. Eye and Ear Inf.	10,235	1902		410		334
Manhattan Eye and Ear Hospital	4,526	1901		143		128
Ditto	5,314	1902		136		111
Total	25,331					746

The greater frequency of these operations, it cannot be doubted, is to a great extent, on account of the skill attained and the confidence acquired in their performance. But to the author it seems there is another reason, which will be made maifest in due time.

The minds of men run in grooves, ruts and surveyed channels. Fashion guides, customs prevail, and creeds

bind the thoughts of each time and period. The bell-wether leaps over an imaginary or real obstruction and the flock goes with him into green pastures or into the turbulent sea. Now and then the non-conformist stands beside the road and dares to question and cry Halt! but the world goes on, and often the objector dissenter or the doubter is trampled out of sight, his warning unheeded until a second or third may dare to demur, and if he have influence becomes a bell-wether on his own tangent. It is as true in medicine as in other walks of life, and its history is full of blind, headlong precipitation as any other field that is not built on fact and reason.

The profession in Otology seems now to be faced all one way, and that toward the development of the path of curing Otitis Media Purulenta by the mastoid route, while the labors of the former generation on the treatment of the Eustachian tube, is ignored. The author believes that this is one of the reasons for the readiness with which the "radical operation" is so often performed.

The writer hopes to make good his remarks, that may seem to the reader pretentious, in showing his methods, followed in treatment of middle ear inflammations.

The operation of trefining the mastoid process itself fell into disrepute because a Danish surgeon by the name of Berger in 1792 caused it to be performed upon himself for "deafness which was accompanied by vertigo, headache and noise in both ears." Meningitis resulted and the patient died in a few days.

The diseases of the ear and their treatment were a jumble of contradictions and inconsistencies down to the generation which has just about passed off the stage.

Dr. D. B. St. John Roosa, in his work on "Diseases of the Ear," gives due credit to foreign authors and especially to Wilde (1843) of St. Mark's Hospital, whom he says "probably did more to place our science upon a sound basis, than anything that has been done in Otology since the days of Valsalva." He recognizes the works of Toynbee, Von Troltsch, Politzer, Gruber, Weber, Rudinger, Hinton and others and many in this country—Knapp, Turnbull, Blake, Burnett and Pomoroy, but there are none to whom America is so indebted as to

Dr. Roosa himself. For clearness of classification and common sense, he is excelled by none other in his writings. On treatment he is most satisfactory.

The drift of all the discussions on the middle ear diseases and in their more severe forms involving the mastoid cells particularly is toward giving vent to the pus collection, in the first case, by paracentesis of the membrane, and in the second, by Antrectomy.

This latter operation is now performed in acute suppurations, and also in the chronic form, for purposes of thorough cleaning, where in neither case, there is immediate fear of involvement of the brain. In the many discussions for several years, and the giving of the history of many cases, there is no mention of getting vent or drainage through the Eustachian tube by use of the Catheter. The manipulation of the Catheter seems to be one of the lost arts.

Some mention occasionally is made of the cautious use of the Politzer bag and some authors advocate use of the Eustachian bogie, while others mention repeated incisions of the drum membrane and cleaning the tympanum by a thorough wet or dry method.

The experience of one who has labored in a different direction to relieve these most difficult and trying group of diseases, may be of interest to those who come in contact with them.

When the method hereinafter described, was instituted, the operation on the mastoid was considered a capital operation, and the wish was to avoid it if possible. This may be the reason of its inception, and promotion and the writer finds it sufficient in a very large percentage of cases. This is the use of the Eustachian catheter and injections of a bactericide through it to the seat of the disease.

The Eustachian tube is the natural drainage tube for the cavity of the Tympanum, and when this tube becomes clogged, the writer deems it the first, and always, the duty of the surgeon to restore it to its function, by the best possible method. Until the natural drainage is established, by some means, the case cannot get well.

The writer, when a boy, moved to Ohio, and was sent with a laborer, to drain a piece of wet land. When his

uncle came out to see the progress of the work, he found us commencing our ditch on the highland end. He has never quite gotten over the chagrin caused by this proof of his lack of common sense thus exhibited.

This tube is a little over an inch in length, divided into two portions, the osseous upper portion, called the isthmus, $1\frac{1}{2}$ to 2mm. in height and $\frac{1}{2}$ to $\frac{3}{4}$ mm. in width, widening out rapidly as it proceeds to the throat in the cartilagenous portion, at an angle, in the adult, of about 40 degrees in direction, measuring at its orifice 9mm. high, and 5mm. broad. (Roosa.) The length, direction and size, varying in age and in individuals of adult age. It is as large in the tympanic orifice, in the child, as in the adult. Besides being more horizontal in the child, it is shorter and wider and consequently fluid passes more readily from the tympanic cavity, through it into the throat. (Macewen.) The ciliated epithelium which lines the Eustachian tube, and partly the tympanic cavity, has the movement of the cilia toward the pharynx. (Macewen.)

The *tegmen tympani* is a wide plate of thin bone, lying between the conuous ear cavity and the dura mater under the brain. It is continuous from the escaping Eustachian tube, anteriorly, over the tympanum (the attic) and continued over the Antrum in the mastoid cells (the latter portion sometimes called the *tegmen antre*.) In adults the antrum is somewhat dropped down, and has not quite the straight relation as in childhood, but this only forms a more secure cup for the pus that may be received from the tympanum. The bone is very thin and often very defective. The petro-squamous suture is sometimes large enough to constitute a perfect "dehiscence" of the roof. (Broca.) A straight probe thrust into the opened antrum, in the case of the child, can be passed through the tympanum, over the audits (touching the ossicles) when it will engage in the Eustachian tube on the other side of the tympanum. (Broca.) This continuous roof is covered over with periostium and lined with mucous membrane, forming a direct guide for a column of air projected through the Eustachian tube, through the tympanum and into the antrum of the mastoid cells.

EUSTACHIAN CATHETER.

Why, in late years, the disuse of the Eustachian catheter, with injections into the middle ear, has come about, is difficult to explain. But that attention is led off to the more brilliant and difficult course of procedure, is quite evident.

The catheter requires skillful manipulation, with a good "muscular sense," and the time put in in acquiring the skill is well repaid. In the time of Wilde, Toynbee, Von Trolsch and Hinton, the catheter was used much more than at this time. More was done to get drainage by the Eustachian tube, and injections of the tube were frequently advocated. The history of the instrument does not show there has been mischief done with it. No cases of death have been reported in the hands of reputable physicians.

In regard to the manipulation of this instrument, the directions given by the books are almost all alike in directing, that on passing the catheter, it should be carried on to the posterior wall of the pharynx, and then drawn forward, and while turning the beak toward the tube, to let it ride over the posterior lip of the trumpet-shaped orifice of the tube, which is generally aided by the patient lifting the palate. The carrying of the catheter to the *posterior wall* is not necessary, and when done, the patient will invariably draw up the palate and catch the catheter, and this incident is the most disagreeable part of the procedure, and very often the patient demands that it be taken out. The second hurt comes on in riding over the lip of the tube. The catheter should be carried in only so far as the posterior nares and turned about the corner and into the tube without passing so far back that when the patient swallows, he can joggle the catheter. If the catheter can be touched by the palate on swallowing, it is too far in. When the entrance of the Eustachian catheter is thus gained, of course the fossa of Rosenmuller is not reached. Sometimes this posterior lip is quite prominent and there is much pain in riding over it.

DIAGNOSTIC OR AUSCULTATING TUBE.

The diagnostic or auscultating tube should always be used. I would as soon dispense with the receiver in telephoning as I would with it, in examining the ear. One who uses it constantly can learn much of the condition of the tube, and I am in accord with Kramer in his declarations that much can be learned thereby. He goes no farther in this than the declarations made in regard to the auscultations of the chest. I prefer a silver catheter, although I sometimes use a vulcanized one but am chary with these in refractory patients, for fear they will be broken. Putting one end of the diagnostic tube in the hand of the patient and directing him to put it in the ear when the proper time comes, holding the catheter in the hand best suited for the side to catheterize (left hand for the left nostril of the patient, and right hand for the right nostril) and placing the other arm across the shoulder, with the fingers on the occiput of the patient I seldom have difficulty, when the nostril has room enough, and the patient is over ten years of age. Children in this country are not sufficiently disciplined by parents, to be handled by a surgeon, and sometimes it is necessary to wrap them up in a sheet or blanket to accomplish a very trivial operation.

It is often advisable to use a swab with cocaine. To cocaine the orifice of the Eustachian tube, wrap a "cable temple" of a spectacle frame, with cotton saturated with a solution of cocaine and carry it into the nares in such a way that it will hug the floor and outer wall of the nares, and when arriving at the posterior nares, it will turn toward the end of the tube; this will not only anaesthetize but swab this locality.

In the beginning of my practice, I used to occasionally have a faint with some susceptible patients, but I learned that this was much my own want of confidence or assuring manner. If I see any tendency this way, I wrap them on the knuckles with the end of the diagnostic tube: with some have dipped my finger in water, and snapped in the face of the patient, when they will generally come to time. Giving them something to do in placing the diagnostic tube in their ear is generally

sufficient to direct their attention from the catheter. Then again much explanation of the process to the patient previous to its performance, is only magnifying the act in the mind of the patient.

CATHETER VS. POLITIZER BAG.

The superiority of the catheter over Politzer's-bag method of inflating the Eustachian tube *when there is fluid or pus in the middle ear*, is very great. The Eustachian catheter occupies only a portion of the caliber of the tube, and the propulsion of the air into it, allows a return current past the beak into the pharynx, carrying the accumulated contents with it. Whereas in the case of the Politzer the pressure of the body of air, acting upon the contents of the tube, drives it forward, and probably over the *auditus ad antrum* into the mastoid antrum. The air penetrates the middle ear and breaks up the secretions, but inevitably, the contents of the tympanum must be more or less driven directly that way, as it is in direct line, and has the ossicles only as an obstacle to its course, which must be swept by the projected fluid. The result of Politzeration, is that a portion of the secretion is gotten rid of over the *auditus*, and it breaks up the bulbous mass, and the good effect arises from the penetration of the air into the cavity of the tympanum and the disturbance of the contents which afterwards drains more or less down the tube. I am as reluctant in using the Politzer, in elderly people with fluid in the Eustachian tube, as I am of incising the drum. I don't know of a *better method of infecting the mastoid cells* with the fluids of the tympanum, than this very process that so many surgeons use, and which, not knowing or suspecting this consequence, is considered as a brilliant and effective performance. The catheter has no such effect, but cleans out the tube by the counteraction of the stream of air forced in by the bag from without. Another point in the use of the bag for inflation through the catheter. I have the nib which fits the end of the catheter, on a rubber tubing about two inches in length, and then joined to the air bag. The hand that presses the bag need not then be in line with the catheter, but be below it. The nib thus placed in the cath-

eter will bounce out if there is too much resistance to the passage of the air into the catheter, which is an indication that it is out of place or some other cause that needs correction. It acts as a safety valve.

INJECTION OF FLUIDS.

In the time of Wilde, Von Troltsch and Hinton, injections were advocated, especially in the treatment of the chronic non-suppurative inflammation of the Eustachian tube and middle ear; with some in large quantities, and others by drops, but the latter of greater strength; sometimes carrying these drops into the middle ear by a middle ear catheter, which was a flexible tube of small caliber pushed in through the ordinary catheter. Hinton advocated the injection of the middle ear through the open drum down the Eustachian tube, the fluid being caught in a cup under the nose. These medications have not been more successful in the treatment of these *non-suppurative* cases, than other methods, and probably brought about the disuse of injections altogether.

CHRONIC NON-SUPPURATIVE CATARRH.

The more common diseases of the ear, and those in which so much has been attempted, are those of the non-suppurative form which comes on insidiously, and causes the deafness of old age. They are the bane of the aurist, and tend more to the disparagement of his reputation than any class of diseases of the ear. They are generally the result of a neglected catarrh which fastened on the patient in childhood, and which caused deafness at the time, but which broke away, and the hearing restored to a degree, but which left a chronic condition which gradually produces changes, that when fixed are very difficult to remedy. This chronic condition can be carried hidden in the cavity of the head, and will not, like the chronic inflammations of the eye, be

attended to because of appearances. When the hearing is reduced in the second ear, to losing common conversation, then they are driven to the aurist and expect quick relief.

MODERN BACTERICIDAL METHOD.

Since the bactericidal method of treatment of the purulent affections, it seems that the revivement of Eustachian injections should be made in the treatment of those diseases which give muco-purulent secretions. The writer has for more than twenty years injected the Eustachian tube through the catheter, in these forms of inflammation of the middle ear. He regards it the first and most rational procedure to get drainage into the pharynx, and that, too, before the paracentesis of the drum, and this is most effectually done by inflating with the catheter, and the injections of fluid. The operation is not nearly so severe as paracentesis, and goes directly toward relieving the cause of the severe symptoms, which in the opening of the drum only relieves the pressure at one end of the tract, and does nothing for the other where the disease is most active and from which the trouble arose.

Since the recommendation of Bezold, of the use of boracic acid in the treatment of purulent diseases of the middle ear, we have a safe and effectual remedy. He however recommended weak solutions of 1 per cent in sterilized water, whereas I have used it in saturated solutions, and indeed am not particular that all of it is dissolved in the hot water, but try to carry it in by suspension. In chronic suppuration where the drum is perforated, I can sometimes inject the Eustachian tube clear into the tympanum, and the patient often turns a few drops out of the meatus. My method is to place the catheter, and make sure it is so, by the diagnostic tube,

then ask the patient to swell the cheeks and incline the head back slightly, then push the fluid through the catheter (two or three drams) with a firm but steady push. The most of the fluid, at once flows back into the pharynx, and with it some of the secretion. It does not go into the throat, if the cheeks are kept inflated. The catheter is then removed and the patient turns to a spittoon, or empties the contents of the nose into a napkin held under the nose. The inflation of the cheeks is important, for if the fluid goes into the lower pharynx it may strangle and cause coughing, or it will go into the stomach, which it is better to avoid.

BACTERIOLOGY.

Parallel with the investigations for the kind of micro-organisms found in the pus taken from the tympanum, should be discovered the germicide that would be most effectual in their destructions. Then the knowledge that is said to be already ours, the micro-coccus lanceolatus the pneumo-bacillus of Friedlander, the streptococcus pyogenes, the staphylo-coccus pyogenes aureus, albus and citreus; the klebs Loeffler bacillus, the bacillus of influenza, and the Diplococcus intracellularis meningitidis, will be of some utility in this connection.

The new chemical substance to which the profession is directed by Professors Frier and Novy of Michigan University called Acetozone, might be of great service here. I have not tried it, but here make the suggestion.

This douching through the catheter, both in acute and chronic otitis media purulenta, has been very satisfactory, in cases before and after the drum has been perforated. The medication has been salutary on the inflamed mucous membrane at the entrance of the tube, and the second injection is better endured than the first,

Indeed the patient is so much relieved, that in the majority of cases, he is anxious to have it repeated. I continue the injections of the Eustachian tube, so long as I get the sound of fluid on its inflation through the catheter. There can be no more satisfactory result in relieving the head symptoms and restoring the function of the Eustachian tube. I have relieved many who had the more severe symptoms: swelling behind the ear, debilitated, high temperature, and severe pain, with symptoms of mastoid complication, with these injections.

CLEANING THE TYMPANUM.

To facilitate the cleaning of the cavity of the tympanum when there is perforation of the membrane, I direct that the patient take a dropper instead of a syringe (which latter is well said by the books, cannot be used by the patient, and very few learn to use it on another). The patient, himself, can use the dropper and make it more effectual in removing the secretions, be they cholesteatomatous in character or less hardened secretion. The dropper should be a double shoulder (French) air tight and smooth at the end. They are directed to three-fourths fill the dropper with the fluid used, always warm, incline the head to bring the ear treated upward, pass the small end within the drum perforation, press it all out into the tympanum, then draw it back again press, so back and forward two to five times, when the dropper is filled with the saturated solution of pus, and emptied, then more solution; proceed in this way until the fluid returns into the dropper clear, when the cavity is dried and a powder of boracic acid is blown in the meatus. It is often that strings of muco-purulent matter are engaged in the tube or dropper, and by atmospheric pressure are held there until they are drawn out. To facilitate the opening and

drainage of the Eustachian tube, I direct that after cleaning, the ear be filled with the injection and then the tragus be pushed down to stop the ear and give a pressure while the patient swallows, when the fluid is often tasted in the pharynx. This indicates patulency of the tube.

It is not my intention to dissertate on the complications found in otitis media purulenta. Polypi, etc., must be attended to as they arise; but in all cases *first*, *last* and *always*, there is the duty of maintaining good drainage through the Eustachian tube.

DOUCHING THE NOSE.

There is a second requisite, fully as necessary, and which promotes the accomplishment of the first, viz: the treatment of the pharynx. Since the report of Dr. Roosa of the dangers of the Thudicum or Webster douche this instrument has gradually become less common in the hands of reputable physicians. There is no doubt, that in the hands of *those best* instructed in its use, the fluid used, will be flooded into the Eustachian tubes and sometimes into the tympanum. In consequence, when used at all, the medication must be so weak that it is innocuous in the tympanum, and this would render it ineffective in the pharynx. The spray-apparatuses that are so common to-day are difficult to use, and in the hands of the patient, are very inefficient. A fluid sprayed is always cold, which is another objection.

DOUCHE AND INHALER.

Our climate, in modern times, seems to be adapted to the development of diseases of the mucous membrane of the air passages. The dust of the cities, the sporules of the flora and grasses of the country, acute colds, the

employments of baking, milling, factory operations, threshing, traveling on the railroad, and, not least, bad ventilation, all tend to the development of local disease. In the majority of cases it is but a local disease; in a few it arises from a low vitality of the system, or an actual constitutional disease; but the nasal cavity, subject to such noxious influences as above enumerated, followed by inattention to the acute stage on catching cold, is left in a semi-inflamed condition, and this is the chronic catarrh; and each successive cold and exposure to irritating influences but adds to the inflammation, and leaves an additional chronic condition. A small percentage of people catching colds have vitality to throw off the local effects with the restoration of the constitutional disturbance; but the majority, after such attacks, experience insidious effects, and a continuance of these conditions break down the health.

It is not strange that the nasal organ should suffer in the new order of things in a forced civilization—suffer in its office of purifying the atmosphere under such modes of living. The too common opinion that catarrh is a disease of the blood, and that it can be cured by constitutional remedies, must be given up. The tone of the system, it is true, will make some difference in the power of resistance of the effects, and this, even, can be heightened by some internal medicines, and people will recover from colds without the chronic effects, but nasal and throat catarrh affect the most robust, as every physician knows who has treated this disease to any extent. The specialty of the diseases of the throat and nose has improved the means of treating these parts, both in instruments for examination and treatment as well as in the remedies for medication. The paraphernalia of the physician in a well equipped office is very satisfactory or office treatment, but the instruments are expensive

and must be handled by experts. The expectation of having patients attend long enough and often enough to be cured, is not realized in the majority of cases, and the consequence is, these troubles have the reputation of being incurable.

The greatest necessity in the case is to secure an apparatus sufficiently simple, agreeable and effective; one that can be easily handled and daily applied by the patient at home. Frequent washings and medication are necessary, and when this is done under proper direction with the remedies, of which we have abundance, disease can be averted, and disease already established can, in a

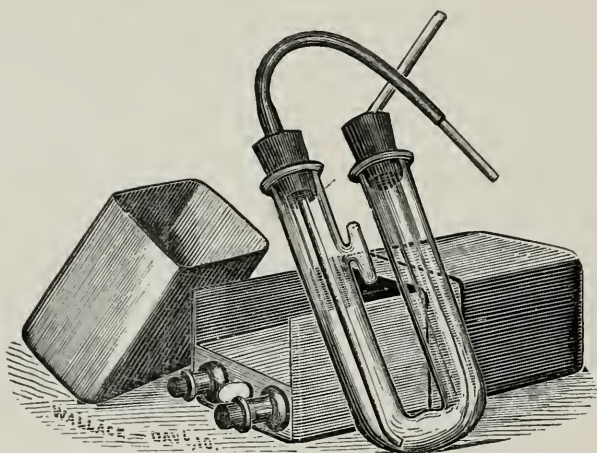


Fig. 1.

**An Apparatus for the Treatment of the Mucous Membrane
of the Air Chambers.***

majority of cases be effectually cured. Neglect of the principles which cause disease in any part of the system, viz: allowing foreign accumulations to remain in the parts and neglecting the proper cure of the acute stages, will inevitably develop the chronic forms, which will result in future suffering or will open the avenues upon

* This Instrument can be had of A. W. Hazen, Des Moines, Iowa.

which the patient makes his exit out of the world. Why catarrhal troubles should be so neglected, and why inattention to them should be so universal, with the idea it is "only a cold", or that "they will outgrow it," seems strange, unless it be because of the generally disagreeable methods practiced.

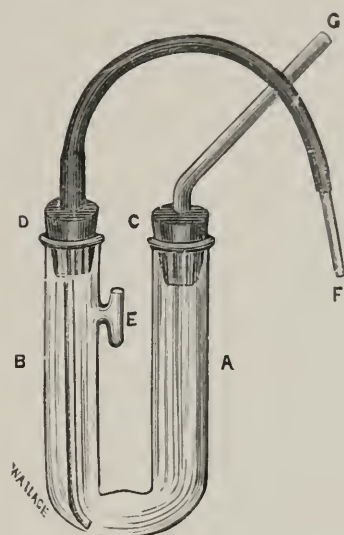


Fig. 2.

Douche and Inhaler.

In 1880 the writer devised a douche and inhaler and an account of it was published in the transactions of the Iowa State Society, 1881. The process of douching by this instrument, is founded upon the fact that by blowing upon a body of fluid in an air-tight chamber, it can be made to rise in a tube thrust in it, and flow out through it into the nose when directed there, and in this act of blowing, the palate presses upon the posterior pharynx, and forms a floor, and will sustain this body of fluid as it rises to the roof of the nasal cavity. If the head is thrown well back, the cavity will hold about an ounce. The fluid thus acted upon, floods the posterior and superior parts of the cavity and on removing the in-

strument from the nose and mouth, it is in the best possible position to be thrown into the anterior parts, by bringing the head forward and at the same time exhaling forcibly.

The safety in this douche is in the fact there is no pressure to carry the fluid into the Eustachian tube, and as the tube remains closed only as the act of swallowing is performed, and that while performing the act of douching, they cannot swallow, it renders it perfectly safe. From this fact it allows, also, medication of such strength, that it will be of more effect than the solutions that must be used in the other forms of douche. The Sphenoid sinus is also medicated quite effectually by this douche and the interstices about this cavity are cleaned by it. The instrument is made of glass and is easily cleaned. This instrument has now been in use for over twenty years in the writer's practice, and no inflammation of the Eustachian tube produced by its use has come to his knowledge.

DIRECTIONS FOR USE.

Showing position of head in act of douching by this method. and the internal parts involved, *t b*, turbinated bones; *d*, sphenoid cavity; *e*, eustachian orifice; *c*, palate closing upper pharynx from lower, upon the act of blowing upon the mouth-piece of instrument; *a*, level of fluid obtained by the use of douche.

FIRST. USE AS A DOUCHE (FIG. 3.)

DIRECTIONS.—Remove cork (*c*, Fig. 2), and pour the fluid to be douched into leg, A; the replace cork; place forefinger on opening at E, other fingers aroynd B, and thumb around A; the introduce end of flexible tube, F, into nostril, straight back, allowing it to rest on the floor of the nose; then put the mouth-piece G, into the mouth (having taken a long breath); blow steadily, inclining the head backward, whereupon the fluid will ascend through the head backward, whereupon the fluid will ascend through the inner tube in B, and flow into the nasal cavity. Before a full breath can be

exhausted, the fluid will overflow out of the nose, or a signal will be given by the air entering the tube at the bottom of B, when the instrument may be removed; and if the cheeks are swelled out by inflation of air, the palate will continue to form a floor and hold the fluid in the nasal capacity. After retaining the fluid for a few seconds, and turning the head from side to side, on bringing the head forward the fluid will run out of the nostrils over the floor of the the nose.

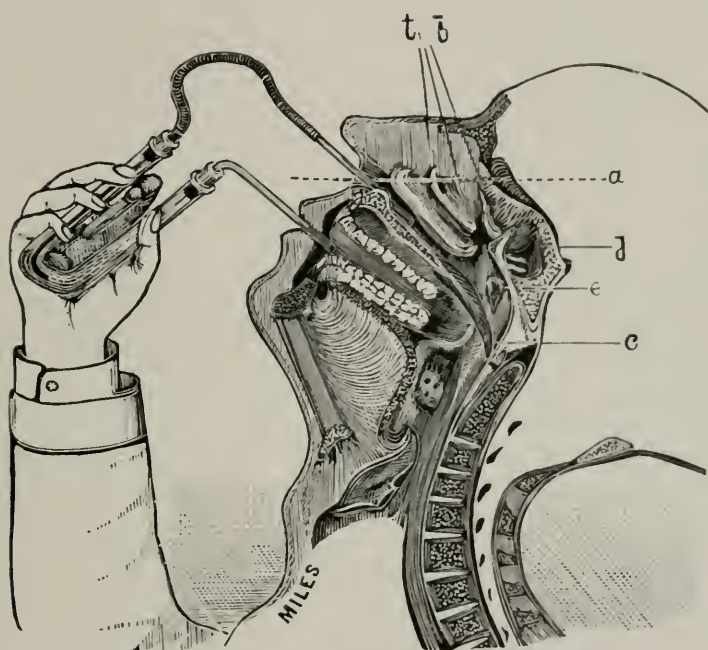


Fig. 3.

ANATOMICAL.

When it is desirable to medicate the turbinated bones (*t b*), anteriorly, this can be effected by coming forward quickly and exhaling from the lungs suddenly, thus blowing the medicine well into the front.

N. B.—A full breath must be taken at the start, and if a pressure is not kept up by a gentle blowing, the palate will not maintain its place. If taking a breath is attempted during the process, fluid will fall upon the larynx, which will cause coughing.

SECOND. STEAM INHALATION (FIG. 4).

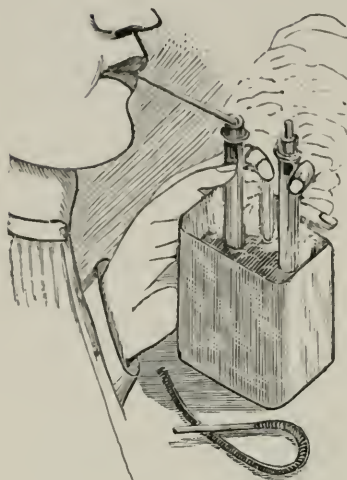


Fig. 4

DIRECTIONS.—Put into leg A, the medicine to be inhaled.

(a) *For treatment of the Nasal Cavity Only.*—Take out the inner tube in B, and put the end of the flexible tube, F, into cork, D, with the flexible tube outside, and place the other end into the nostril, with the forefinger on E, and *blow* into the mouth-piece. By this method the nasal cavity can be treated without medicating the throat or lungs.

(b) *For Medicating the Whole Mucous Membrane of the Bronchial Tubes, Throat, and Nose* (Fig. 4).—Take off the flexible tube; put medicine into leg, A; put the forefinger over vent, E; draw steadily at the mouthpiece, G (a piece of cotton wadding or sponge can be put under cork, C, but generally it is not needed). The vapor is inhaled directly into the lungs and exhaled through the nose. The fluid in the bottom of the U tube can be kept hot by immersing the U tube midway into a cup of hot water or sand.

THIRD. DRY VAPOR INHALATION (FIG. 5).

DIRECTIONS.—Put medicine for vaporizing on cotton as at H, Fig. 5

(a) *For treatment of the Nasal Cavity Only.*—Put end of flexible tube, F, into the nostril, forefinger on E, and *blow*.

(b) *For Medicating the Whole Mucous Membrane of the Bronchial Tubes, Throat, and Nose.*—Take off the flexible tube, and *draw* into the lungs through the mouth-piece; and exhale through the nose.

N. B.—The temperature of the air brought to the mucous mem-

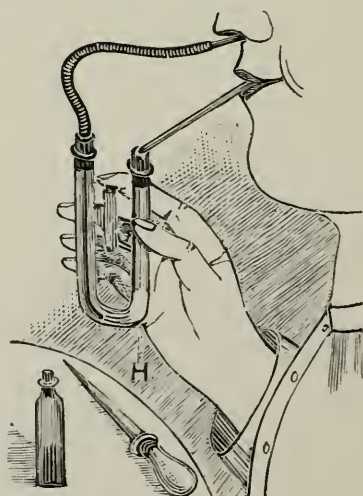


Fig. 5.

brane can be raised and the medicine more readily vaporized by putting the U tube into hot water or sand, as in Fig. 4.

FOURTH. AMMONIA INHALATION (FIG. 6).

DIRECTIONS.—To leg, B. (Fig. 2), a small bulb, E, is firmly attached—a receptable for the Muriatic Acid. In this, first put a small amount of absorbent cotton, loosely packed, on which drop three drops of the acid. Put the Ammonia (about 20 drops) and two teaspoonfuls of water in bottom of U tube. Then add medicine as required. Then place forefinger on end of tube at D. Upon inhaling at the mouth-piece, G, nascent Muriate of Ammonia will be generously produced. To prevent the Ammonia from being inhaled before the acid comes in combination with it, place a piece of moist sponge under cork, C, Fig. 6.

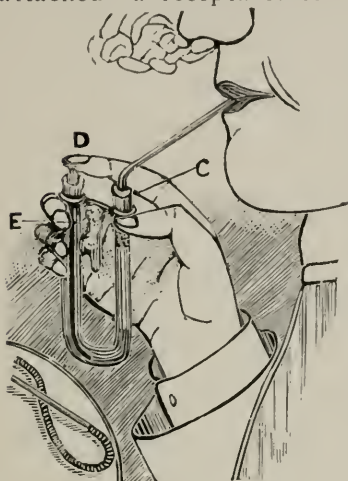


Fig. 6

FIFTH. TO USE IN THE EXTERNAL EAR (FIG. 7).

DIRECTIONS.—To douche the external ear, fill the instrument; put the tube, F, into the meatus, and blow the fluid into ear by blowing on the mouth-piece, G, and holds a small vessel under the ear.



Fig. 7.

In case of earache (Fig. 7): Take out cork, D, (Fig. 2), with inside tube and the flexible tube; take off flexible tube, and take out the long glass tube: re-

place the cork. Now put the glass end of flexible tube, F, into cork, and then put the straight end of the long glass tube on the other end of flexible tube, and it is arranged as in Fig. 7. Put two teaspoonfuls of hot water in U tube, then put U tube into hot water or sand; place the bent edge of glass tube into the ear, with forefinger on E, and blow gently at the mouth-piece; the warm vapor should be blown directly onto the drum, and it will almost invariably relieve the pain.

SIXTH. POWDER BLOWER—INHALATION (FIG. 9).

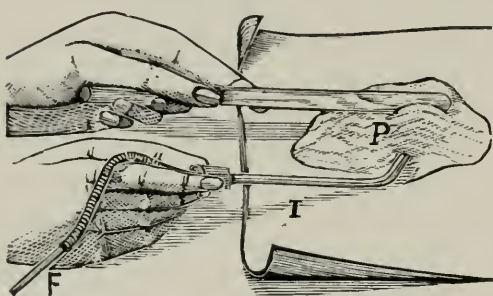


Fig. 8.

DIRECTIONS.—Take out cork, D, with glass tube and flexible tube. Put powder on paper, and push it with a knife, as shown in Fig. 8, into end of tube, I; then by placing the end of the tube thus loaded into ear

or nose, as required, and the end, F, into the mouth, the powder can be blown into the part. A second person or an airbulb is required when the nasal cavity is medicated from behind the palate. The bent end is introduced into the mouth and the medicine is thrown into the nose from behind the palate.

CAUTION.—The temperature of fluids for douching should be above blood heat. In all these methods, in order to make the instrument work satisfactorily, it is necessary that the corks be air-tight. Patients using the instrument in the winter should not go into the open air for half an hour.

DIRECTIONS FOR CLEANING.

Empty the instrument of cotton, etc.; replace corks; place the end, F, into water, and *draw* at the mouth-piece until the instrument is nearly full; then shake, and *blow* out the fluid, reversing its course.

DOUCHING OF CHILDREN.

It cannot be expected that children under ten years of age will be able to douche the nose. For those of over four years of age, I fill the common vulcanized syringe with the fluid to be injected, and put the child in front of me, with his back against me and holding the face steadily by placing my hand under the chin, and stretching his neck a little, cause him to swell the cheeks, when I place the nozzle in one nostril, directing the stream back over the floor of the nose with some considerable force, when it will return out at the opposite side in a stream into the spittoon placed in front. If the child will keep his cheeks swelled out, no fluid will pass into the throat, and the cavity is fairly medicated. To medicate the region of the Eustachian tube on the opposite side as well, the injections should be given in a similar manner on the opposite side.

The writer regards douching of the nose with warm solutions, much more favorably than sprays. The latter in the hands of the skilled operator may be effectual in cleaning the interstices of the cavity of the nose, but the spraying is a cold process and all the erectile tissues of the cavity are excited and catheterization is more difficult and painful afterward. The douching by the instrument above described is directed by the author, to be done before visiting the office, or before his visit at the home, and the locality is generally clean, and all excitement will have subsided. More thorough cleaning is sometimes necessary, but not often.

The writer has repeatedly cured acute cases of otitis media purulenta by this method when, in the light of the present day, many surgeons would decide on an-trectomy, and in many cases this had already been advised. He believes that when the tympanum is relieved

of the pressure of fluids, by giving vent through the Eustachian tube, the contents of the mastoid antrum can be, and are drained from this cavity; that in many natural positions of the head, when in this condition, fluid escapes into the tympanum and out by the Eustachian tube. At least the products of inflammation escape or are absorbed, for mastoiditis gets well without opening the cells.

A few cases are herewith appended:

Case 1. Miss E. A., young lady of 18 years, was brought to my office by her attending physician, November 19, 189—. She was pale and acenemic, having lost fifteen pounds since becoming sick. She had to be supported in walking, becoming dizzy when on her feet. She held her head to one side. Behind the right ear, over the mastoid, there was a swelling that was red and fluctuating, and caused the ear to stand out at nearly right angles to the bone. She had the following history. On the 27th of October, after riding about two miles she had a sore throat, and in three weeks had earache. The drum broke the next day, since which time she had been treated with tonics, narcotics, Politzerization, fomentations and syringing the auditory meatus. The ear remained closed, however, and the heavy dragging feeling was not relieved.

I at once introduced the catheter and injected the Eustachian tube with solution of Boracic acid ; afterwards blew out with air bag and catheter which opened up the ear. After blowing in the powder of the acid in the tympanum, she went to her boarding place. The next morning at 8:30 I found that she had had the best night's rest since she became sick. Swelling behind ear had gone down two-thirds. She was eating her breakfast and feeling in good spirits. Injected as before, the solution penetrated well up into the tube and opened the cavity. Left douche to be used twice a day with solution of Potass cholras and Borax each four and a half grains to the ounce of water. To syringe ear with pipette, as described in these pages, and then blow in the meatus powder of Boric acid. This case was thus treated daily for seventeen days at which time the discharge was stopped, hearing good, and improved in general health. No tonics, or narcotics were given.

Case 2. E. R., December 6, 1894, a girl of 13 years found lying in bed and very weak. For ten days had had pain in right

ear, but was relieved after three day's suffering, to a considerable extent, by breaking of the drum and a discharge from the ear. The former physician had given her internal medicines but made no application to the ear. She was so reduced in strength that she had to be propped up with pillows, while introducing the catheter. I treated her as in the former case six days in succession when ear seemed perfectly well, and though she remained in bed two weeks thereafter under the care of another physician for malaria or la grippe, her ear troubled her no more.

Case 3. E. R. T., a young man of twenty years, a photographer came to my office December 17, 1894. Two days before his ear commenced to pain from a severe cold he had caught. He was reduced in strength and was suffering intensely. Found drum bulging which I incised and injected as in other cases, blowing air in afterwards through the catheter, which opened up the ear and made it lighter. Up to Christmas (eight days) ear continued to discharge from the meatus, but then ceased, but the sound on blowing through the catheter, was persistent, and I treated him after this time although he returned to his work. The treatments were now at longer intervals, and I discharged him cured with good ear on the 6th of March.

Case 4. Mrs. W., a middle aged lady. Called to her home at 9 o'clock in the evening of April 19, 1893. She had had an attack of gastritis and was under one of our best physicians. She claimed that she had no nasal catarrh, but acknowledged that there was some dropping down the posterior pharynx and some cough. She was having earache in right ear and was applying hot fomentations and douching the ear. The external ear was so swollen that I could not get a view of the drum, but there was no discharge. I treated this case with the air bath with the catheter, which gave immediate relief, and in the morning injected the boracic acid solution. Ten treatments in this case gave permanent cure and a good ear.

Case 5. R. B. S., May, 1899. Farmer, age 31. Called in consultation with one of the first surgeons at Mercy Hospital. Had had severe inflammation and earache for four weeks in left ear. Pain mostly behind ear, far back; tender on pressure. Was so much debilitated that the surgeon deemed it unsafe to undergo an operation. While sitting up in bed I introduced the catheter and injected the Eustachian tube with Boracic acid solution. Douching of the nose was then directed to be given with the U tube twice a day, two doses at a sitting. The next morning found that the patient had had the best night's rest than for many nights.

Repeated the treatment daily, and washed out the external meatus as well, dried with swab and blew powdered Boracic acid. In a few days the Eustachian tube became pervious and on injections there would be a few drops of fluid in the external meatus. The discharge which was ropy at first, lost this quality and in fifteen days he was sufficiently recovered to be able to attend at the office. He, however, had a relapse by catching cold and his surgeon performed the Mastoid operation.

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
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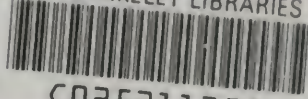
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